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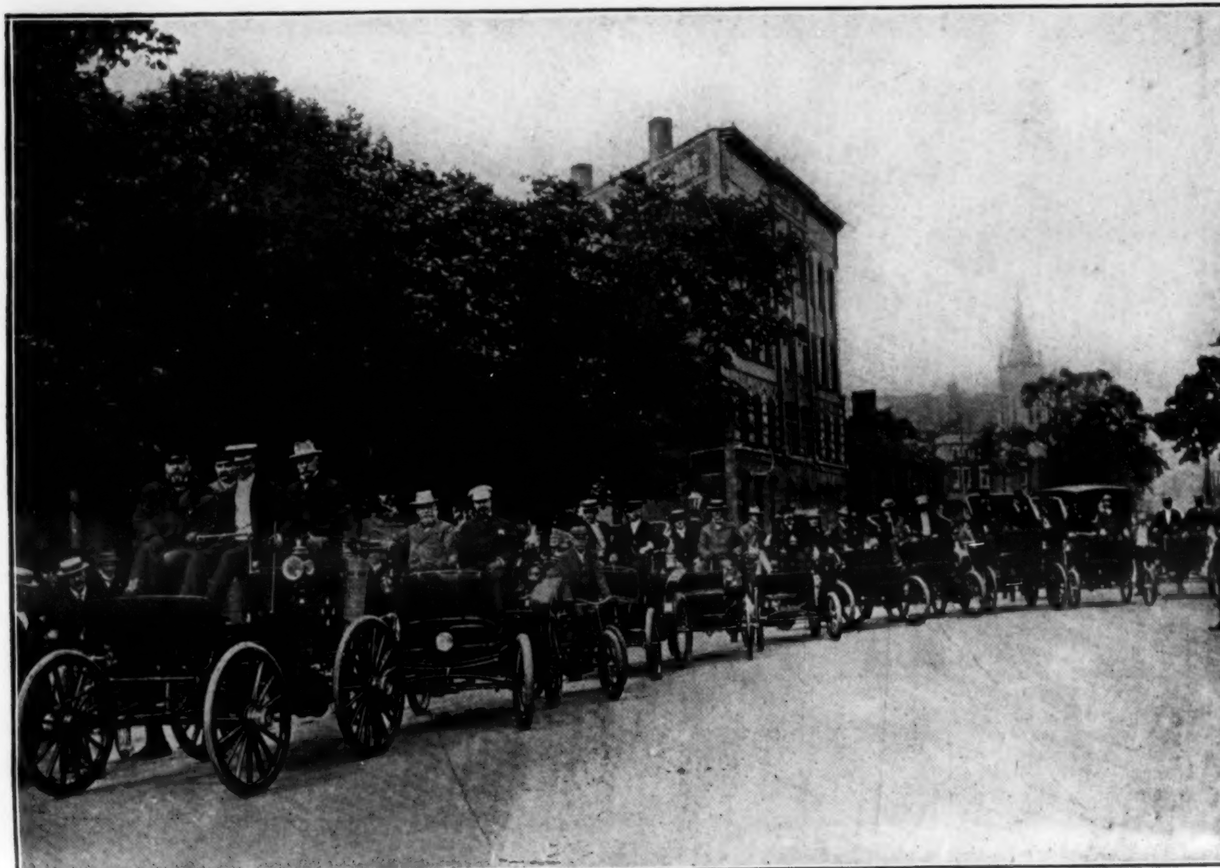

The Start of the Second Run of the Buffalo Automobile Club, July, 1900

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Trend of Progress of the Automobile

By R. H. Thurston

Fourth Paper

DRY steam must be had, not only because the engines, if properly constructed, will have small " dead spaces " and cannot safely work water in any appreciable amount, but also as an element of economy. Moderate superheating, in fact, is most desirable if obtainable without too great sacrifice of lightness and compactness of boiler. A gain of very considerable amount should follow superheating, through reduction of internal wastes in the engine, and it would compensate, by its reduction of the fuel carried and expended, a correspondingly considerable enlargement of the boiler with increase of weight and size. The opportunity thus to secure a gain in the average automobile engine is not improbably in excess of fifty per cent. of its present expenditure of heat, steam and fuel.

With steam-wagons for commercial work, the problem of the engineer assumes very different form in some respects. He may find it wise to adopt the shell-boiler if he finds difficulty in choosing or designing a " safety " boiler and he can employ a larger area of heating surface and a heavier steam-generator altogether than with the high-speed pleasure carriage. He may adopt large sizes and high powers and will need but a comparatively low speed and that speed will be better maintained. The conditions, on the whole, are decidedly more favorable to economical and low-cost operation. Rubber tires are not demanded and

details may be designed with reference purely to the main purpose of transportation and without much regard to prejudice or to the comfort of the rider or driver. Width of tire can be adapted to the work and an inch of width, if desired, to the ton of load may be secured, and half that width is probably likely to be found desirable for heavy work. Solid fuel may be here used and it has usually been found that anthracite coal or coke is preferable, all things considered, to liquid fuel. Frost, however, is a real danger with this construction.

Serpollet, in the principle introduced by him with his singular and, for general purposes, apparently, not remarkably promising boiler, seems to have brought us a clue that should be followed with the most thoughtful and persistent care on the part of the steam-automobile designer. This principle may be enunciated as that of employing, where the presence of water is a load and a source of annoyance if not of danger, a comparatively large mass of metal; thus securing the regulating action of water together with that safety which comes of its absence and of the immense strengthening of the chambers containing steam which is consequent upon the use of very heavy tubes. The iron stores heat when the machine is not in action and gives it out as the demand for energy and the supply of heat from the fuel fluctuate in opposite directions and the desirable accumulator effect is thus obtained. This system has been in use, with the automobile, particularly, for now many years and it seems to many engineers both sound and promising. But whatever may prove to be the outcome of that particular device, its principle is one to be kept carefully in view in all automobile construction in which steam is the motor. It would be difficult to find a safer system of construction than that embodying this idea, and perhaps otherwise quite impossible without large weights of water in the boiler, to secure the needed regulating action of stored heat-energy. A boiler without water capable of carrying hundreds of atmospheres pressure, economical and compact, is aimed at.

Mechanical, chemical and thermal storage and regulating action should all be carefully studied from this point of view and the comparison of the energies of fuel, of compressed air, of electricity and of heated water and metal offers an enticing field of research for the automobilist. It is not enough to find that either one or another affords an opportunity to secure a better commercial result than can be obtained with the horse-drawn vehicle; the real question for the engineer, the builder and the automobilist is: Which gives the best and cheapest and most safe and reliable commercial result?

Trend of Progress of the Automobile

The Internal Combustion Engine adapts itself to the automobile in a remarkably satisfactory manner, although still subject to its own special faults—as have been found to be all motors. It has been built in large numbers and has taken part in the evolution of the automobile in a most extensive and promising manner. It has been the winner of many long-distance races and is finding place in every line of automobile work. European engineers and constructors have hitherto accomplished more with this motor than have those of the United States; but the indications are that it is on the verge of extensive evolution in this country and it has already performed admirable work in the hands of a few builders and users. It is anticipated that the proverbial American inventive genius, combined with the intelligent and well-informed mind of the American mechanic, will soon produce marked improvements in this machine and may develop an automobile that, for long routes over country roads, particularly, will find extensive employment and prove satisfactory both in performance and in costs.

Those forms of engine of this class now in use are almost all of the standard type of stationary machine with single cylinders, water-jacketed, and comparatively heavy. It is probable that they may be made much lighter without sacrifice of strength, durability or efficiency, and doing away with the water-jacket, become quite independent of a water-supply. In small sizes, it is perfectly possible to secure cooling by simple conduction and radiation from the exterior and devices long employed in steam-boiler work for increasing the rate of heat-absorption are here available for insuring satisfactory rates of heat-dispersion. For the larger powers, this may also involve the multiplication of working cylinders and the use of separated compression pumps; but the gain is so great that it may be found that even somewhat expensive systems of construction may pay well. Cooling by external flanges has been known in this country for many years to be effective, and such engines were designed by Mr. George B. Selden, of Rochester, N. Y., and for this special purpose, some years ago, for sizes up to about 4 horse-power. The cycle adopted is usually that of Beau de Rochas, commonly denominated the Otto cycle, and the methods of ignition are, as a rule, electric, either the spark or the hot tube and spark together for greater certainty of action. Transmission of motion is best made as direct as possible and the belting and bevel-gearing, loading up foreign constructions so seriously and involving so much risk of trouble, are not favored with us; nor is the system com-

pelling the throwing into gear of a rigid clutch or setting gears into side-mesh in changing speeds.

The principal difficulties with the oil-vapor or gasoline engine and other types of internal-combustion machine, at the moment, seem to be that of starting from rest and that of reversal when in motion, and also some trouble in varying speed without loss of efficiency of engine or even extinction of the combustion. Once *en route* and at full speed, the machine behaves admirably, and, so long as steady speed and constant loads are maintained, power, economy, lightness, convenience and, in fact, substantially all the requirements of a successful motor are illustrated. Starting, reversing or changing speed, however, are very apt, with many of these machines, to reveal serious difficulties. These difficulties, however, we may be sure, will ere long be completely removed by the American inventor and the scientifically trained designer. Some system of storage of energy will supply the reserve power needed for application in starting up and some system of automatic adjustment of the elements of the charge to the speed and load, and a way of starting in either direction as well as of reversing with certainty, will be discovered and introduced. This type of machine seems, in some respects, at least, the most promising of all the heat-motors, and it may find extensive application throughout the whole range of use of the automobile. An internal-combustion engine that can satisfactorily operate with varying speeds, loads and road-gradients, and especially one capable of starting from rest on a heavy grade with the brake on, is still needed.

The gas-engine varies in efficiency with load and with size, much as does the steam-engine. Thus: a gas-engine rated at a maximum as of 12 developed horse-power and which consumed 48 cubic feet of a stated gas per horse-power-hour when delivering one horse-power, demanded at higher powers up to the limit of its rating about $V = 48 \sqrt{P}$; where P is the number of horse-power delivered at the shaft.

The total efficiency of the gas-engine, measured between fuel and shaft, is often about double that of the steam-engine of similar power, and averages not far from 12 in the latter and 20 to 25 in the former. Where gas-producers are employed, they cost about as much per horse-power to be delivered from the engines as do steam-boilers per delivered horse-power. The "stand-by" losses are comparatively small with the gas-engine. In automobile work, the working fluid is always the vapor of some volatile hydro-carbon. It is stored in large quantity in small space and weight, is convenient to handle, need not be dangerous and

requires no delay awaiting the heating up of the apparatus before starting. Its use in the gas-engine brings with it special difficulties for the automobilist. It is difficult to operate the engine at a varying speed as it results in uncertain action of the explosive charge and introduces waste of the combustible and annoyance of the operator. The gas and vapor engines using internal-combustion systems are peculiarly subject to loss with low powers and with variable speeds.

The "working fluid" of the internal-combustion engine as employed for automobile work, must necessarily be such as will be transportable conveniently, *i. e.,* must be, in its initial condition of little volume and weight for the unit of work performed by it. This means, evidently, that it must be carried in the liquid or solid form; but the latter is impracticable while the former is entirely practicable in the case of the light petroleums and other volatile combustible liquids. The internal-combustion engine of the automobile therefore commonly consists of a system involving provision for the volatization and explosive combustion of the petroleums, as benzine, gasoline and other trade products of suitable character. The values of these substances as working fluids are not very different if equally well burned in the engine. The heavier petroleums give more difficulty than those of low density in their ignition and combustion while having the special and important advantage of freedom from danger of accidental ignition and explosion outside the engine. The use of ordinary kerosene, such as is employed in illumination, will perhaps be ultimately generally adopted as the best compromise between availability and safety and as being that material which can be most certainly depended upon in making long journeys and outside the cities.

In France and especially, at this time, in Germany, the cost of alcohol is comparatively low and it is an entirely practicable working fluid for these engines. In the alcohol we have about one-half of the carbon of the petroleum exchanged for oxygen and it requires twice as much by weight of the former to supply the same quantity of heat of combustion. Alcohol has also been employed carbureted and with good results thermodynamically; although costs have hitherto proved prohibitory. In Germany, where alcohol is exceptionally cheap, the costs are not so different as to absolutely preclude its use.

Heat-storage in Water and in Steam are forms of energy-storage which have been sometimes proposed in the endeavor to avoid the difficulties, annoyances and accidents which are liable to be met with where fire and an explosive material are used in

transportation. By heating confined water to high temperatures it is possible to thus store considerable amounts of energy; yet it will be found, on computation, that this scheme involves the use of heavy storage-tanks and involves risks of explosion. The non-use of fire and the absence of the risks due to the exposure of the metal to intense heat of furnace gases, to the action of corrosion by heat and moisture and to the injuries resulting from excessive strain coming of varying temperatures in different portions of the structure, are advantages, however, of real importance. This system has been tried in various forms and on various occasions, and the latest and best examples, where street-railways have been thus experimentally operated, have, it is said, proved quite successful in these respects; but the fact that, even then, the storage was reinforced, ultimately, by a fire shows that storage in fuel is, after all, the most satisfactory method of potential energy-condensation yet discovered. The system still remains one of promise rather than of performance. It stores about 15,000 available foot-pounds per pound of water; coal stores ten millions. If made successful from the standpoint of the automobilist and the promoters of the street-railway, it would give an ideal system in respect to freedom from smoke, fire, sparks and noise. It would be operated much as the compressed-air systems are managed. A fair comparison of the costs and relative advantages and disadvantages of these systems would be interesting. It has been many years since it was introduced by Dr. Lamm; it seems surprising that its place has not been already definitely settled. The accompanying tables of available storage of energy in steam and water are in this connection very instructive:*

* Manual of Steam Boilers; R. H. Thurston; N. Y. and Lond.; Z. Wiley & Sons and Chapman & Hall.

I.—Total Stored Energy of Steam Boilers.*

Type.	Area of		Pressure. Lbs. per Sq. In.	Rated Power. H. P.	Weight of			Stored Energy in (Available).			Energy per lb. of		Maximum Height of Projection.		Initial Velocity.	
	G. S.	H. S.			Boiler.	Water.	Steam.	Water.	Steam.	Total.	Boiler.	Total W't.	Boiler.	Total.	Boiler.	Total.
	Sq. ft.	Sq. ft.			Lbs.	Lbs.	Lbs.	Foot lbs.	Foot lbs.	Foot lbs.	Ft. lbs.	Ft. lbs	Feet.	Feet.	Ft. per sec.	
1 Plain Cylinder......	15	120	100	10	2,500	5,764	11.325	46,605,200	676,698	47,281,898	18,913	5,714	18,913	5,714	1,103	606
2 Cornish.............	36	730	30	60	16,950	27,471	31.45	57,570,750	709,310	58,260,060	3,431	1,314	3,431	1,314	471	290
3 Two Flue Cylinder.	20	400	150	35	6,775	6,840	37.04	80,572,050	2,377,357	82,949,407	12,243	6,076	12,243	6,076	888	625
4 Plain Tubular......	30	851.97	75	60	9,500	8,255	20.84	50,008,790	1,022,731	51,031,521	5,372	2,871	5,372	2,871	588	430
5 Locomotive.........	22	1,070	125	525	19,400	5,260	21.67	52,561,075	1,483,896	54,044,971	2,786	2,189	2,786	2,189	423	375
6 "	30	1,350	125	650	25,000	6,920	31.19	69,148,790	2,135,802	71,284,592	2,851	2,231	2,851	2,231	428	379
7 "	20	1,200	125	600	20,565	6,450	25.65	64,452,270	1,766,447	66,218,717	3,219	2,448	3,219	2,448	455	397
8 "	15	875	125	425	14,020	6,330	19.02	64,253,160	1,302,431	65,555,591	4,677	3,213	4,677	3,213	549	455
9 Scotch Marine......	32	768	75	300	27,045	11,765	29.8	71,272,370	1,462,430	72,734,800	2,689	1,873	2,689	1,873	416	348
10 "	50.5	1,119.5	75	350	37,972	17,730	47.2	107,408,340	2,316,392	109,724,732	2,889	1,968	2,889	1,968	431	356
11 Flue and Return Tubular.........	72.5	2,324	30	200	56,000	42,845	69.81	90,531,490	1,570,517	92,101,987	1,644	931	1,644	931	325	245
12 Flue and Return Tubular.........	72	1,755	30	180	56,000	48,570	73.07	102,628,410	1,643,854	104,272,264	1,862	996	1,862	996	346	253
13 Water Tube.........	70	2,806	100	250	34,450	21,325	35.31	172,455,270	2,108,110	174,563,380	5,067	3,073	5,067	3,073	571	445
14 "	100	3,000	100	250	45,000	28,115	58.5	227,366,000	3,513,830	230,879,830	5,130	3,155	5,130	3,155	575	450
15 "	100	3,000	100	250	54,000	13,410	23.64	108,346,670	1,311,377	109,624,283	2,030	1,626	2,030	1,626	361	323

* This "stored" energy is less than that available in the non-condensing engine by the amount of the latent heat of external work $(p_1 - p_2)v$.

II.—STORED ENERGY IN THE STEAM SPACE OF BOILERS.

Type.	Energy, Total.	Stored in Steam (ft. lbs.) per lb. of Boiler.	Height of Projection.	Initial Velocity per sec.
1. Plain cylinder	676,693	271	271 ft.	132 ft.
2. Cornish	709,310	42	42 "	32 "
3. Two-flue cylinder	2,377,357	351	351 "	150 "
4. Plain tubular	1,022,731	108	108 "	83 "
5. Locomotive	1,483,896	76	76 "	69 "
6. "	2,135,802	85	85 "	74 "
7. "	1,766,447	86	86 "	74 "
8. "	1,302,431	107	107 "	83 "
9. Scotch Marine	1,462,430	54	54 "	59 "
10. "	2,316,392	61	61 "	62 "
11. Flue and return tube	1,570,517	28	28 "	42 "
12. "	1,643,854	29	29 "	43 "
13. Water-tube	2,108,110	61	61 "	59 "
14. "	3,513,830	79	79 "	71 "
15. "	1,311,377	24	24 "	39 "

The study of this table is exceedingly interesting, if made with comparison of the figures already given, and with the facts stated above. It is seen that the height of projection, by the action of steam alone, under the most favorable circumstances, is not only small, insignificant indeed, in comparison with the height due the total stored energy of the boiler, but is entirely too small to account for the terrific results of explosions frequently taking place. The figures of Table II. are those for the stored energy of steam alone in the working boiler; they may be doubled, or even trebled, for cases of low water; they still remain, however, comparatively insignificant. The enormous potential, stored, energy of the steam-boiler, in its usual form, is that of the enclosed mass of hot water.*

Compressed Air, stored in tanks and carried under the vehicle has been often and extensively used for propulsion of automobiles and, in mines and in tunnels, where the exhausted air replaces the smoke and gas and dust of the coal-fired locomotive, it has often been found to be an ideal arrangement. It has frequently been used, during a generation past, for the propulsion of street-cars, and with some measure of success, in competition with horses, but not with steam or the internal-combustion engine. At even so high a pressure as a ton to the square inch, the weight of the tanks amounts to somewhere near a hundred pounds, if safe, per cubic foot capacity, and including but about ten or eleven pounds of air, yielding in work but about a quarter or a

* Steam Boilers as Magazines of Explosive Energy; Trans. R. S. M. E., 1884.

third of a horse-power-hour, according to efficiency of machinery. The storage battery gives two or three, if not four, times this yield in good work. Compressed air thus does not seem likely to serve the automobilist satisfactorily at present, at least, except as an auxiliary when starting under load the internal-combustion engine. Here it may yet find a useful place.

Carbonic Acid gives no more promise, practically, so far as can be now seen, than compressed air, and its cost is to be added to that of the air in the uncompressed state. Nearly all such expedients in the substitution of other fluids as the thermodynamic substance of the heat-engine are urged on the ground of comparatively small latent heat of vaporization or expansion; but there is nothing at all in the argument and, in fact, the best substance is that containing the largest store of this form of potential energy and this is the more important as the substance is the more costly, the measure of the capacity for storage being increased by the value of the latent heat.

"Liquid Air," of late strongly urged as a source of power for the automobile, probably has much less of promise than its promoters believe, or at least assert. It stores comparatively little energy, is enormously costly, especially as a competitor in energy-storage with fluids of little or no cost, requires very large quantities per horse-power delivered, and no known way exists for its storage for any considerable or satisfactory period without immense waste. According to Linde, perhaps its most successful and experienced and reliable producer, it requires a hundred horse-power at the compressor to produce as many pounds per hour, and it can develop but a fraction, probably a small fraction, of that amount of power in regasifying. It loses by simple vaporization, even in large vessels, ten gallons and upward, about four per cent., under the most favorable conditions for its preservation, each hour. Its efficiency in the motor is found to be about four per cent.; that of the steam-engine is from seven to twenty and more, and that of the gas-engine ranges to still higher figures. In the perfect heat-engine, the quantity of air required to do the same work within the same range of temperature of operation is about sixteen times as much as of steam; while steam costs nothing as a crude material and liquid air costs no one knows precisely what—probably not less than three or four times, perhaps ten or fifteen times, as much as the fuel used with the steam-engine or the gas-engine. The wild claims of the promoter of the stock-company, now in the market for speculative purposes, are probably based on but little better reason than those of Keely or of other mountebanks, often self-deluded, who

continually crop up on the "street" in New York, Boston and Philadelphia. Taking its cost in the engine at the advertised minimum, about $8 per ton, and that of steam in the engine at about $0.00025 a pound, about 50 cents a ton, and $4 for coal, the relation is sixteen to one in favor of steam, per pound, and many times this per horse-power developed. A first-class steamship of 10,000 horse-power would probably pay $100,000 for the air alone, to operate the proposed system of machinery in a single voyage across the Atlantic. We are, however, still awaiting exact data and the proposing investor in this field will meantime do well *first* to ascertain the exact character and records of the men with whom he must deal, their intellectual as well as moral reliability and their standing as scientific men, as well as mechanics and mechanical engineers; *next* to secure by personal observation and measurements, or through a trustworthy and reputable expert in that specialty, precise figures of power expended, product secured and costs of power and of product, and, finally, its availability as shown, not through prophecy but by actual experimental and life-size work, for the particular purpose in view. It is always perfectly practicable to ascertain just what the business side of the proposition may be expected to prove to be worth through a careful and accurate investigation, by properly conducted experiments, by well-known and reliable methods familiar to every member of the engineering profession. The same remarks apply to the unknown facts of automobilism generally.*

The Electric Automobile consists of a storage battery and a motor. The former is heavy, at best, and very costly; the latter is a very satisfactory apparatus. The battery may be either of the two usual forms, the Faure system of chloride, "paste," battery and the older Planté arrangement of several makes. The fundamental patents on the latter are open,† those on the former

* The best evidence that the writer has thus far collected, indicates that the cost of even refrigeration, in ordinary cold-air work and transportation, as of fruits by train, must be several times as much with liquid air as with ice; the former, costing many times as much as the latter, pound for pound, is capable of far less refrigerating effect per pound. In no ordinary work can liquid air compete with ice or the refrigerating machine. European experiments indicate liquid air to be far less effective as an explosive, in any form yet devised, than the familiar and cheaper "high explosives." In production of power in a heat-engine it is necessary first to produce the air and at a cost about sixty-five times as great as that of an equal weight of ice, then to use it thermodynamically under the most unfavorable of working conditions. Its work, following Linde's data, may be about one horse-power-hour for eighty pounds, as against fifteen to thirty pounds steam in the engine, or two to four pounds of coal, at least twenty to one in weight and a hundred to one in cost. The use of this most interesting and widely heralded product will probable long, if not always, be confined to work in which costs are of little importance, as in surgery.

† The Planté battery or "accumulator" as it has often been denominated, was brought out by M. Gaston Planté about 1860, and his work continued in its development until 1879. The patents of Faure, the later inventor, were mainly on methods of mechanically applying the "paste," the active material of the storage battery, to the grids, a system apparently known to Planté, but not introduced by him to public use. Brush, the American inventor, however, anticipated Faure and his claim has been sustained by the courts, not only as anticipating Faure but also Metzger, whose patents were issued in 1879. The older method of putting the paste in place was by the tedious system of electrical deposition, as first employed by Planté. Leaden grids with lead-peroxide material as the active element are at present the only forms of storage battery composition found satisfactory commercially.

are strongly held. The Planté system appears to be giving good results, as now used, comparing well with anything produced. One very light French battery is finding tolerably extensive use as particularly adapted for the comparatively hard work of the automobile. The motor is commonly the series-motor, sometimes one and, for heay work, especially, sometimes two driving the carriage. One motor to each driving wheel is thought by many to be much preferable to a single motor driving both; the differential gear, ingenious and effective as it is, proving on the whole undesirable, if it can be avoided. Where it is used, it is, by preference, employed on the motor-shaft, as a rule. The batteries and controllers are so arranged that the several compartments of the battery may be used in multiple or in series as may be found at any moment best. Commonly three combinations, giving as many speeds on the level or at constant load, are adopted. The shunt or compound-wound motor, recharging the batteries when runing down hill, has been suggested frequently, but has not been yet made available.

The Storage Battery is still capable of immense improvement in reduction of weight and bulk and especially, perhaps, in costs, to adapt it to general purposes and still more to the use of the aëronaut and of the automobilist. When the battery weighs from five to ten, or even fifteen, times the theoretical weight and its cost is from five to ten times that of the material from which it is made, it is obvious that, if of any use at all for transportation purposes to-day, it should, in time, when these obstacles to its introduction are in some measure removed, find comparatively frequent and extensive employment. This constitutes the ground of a reasonable hope that the electric automobile—and perhaps even the electrically propelled aërodrome—may yet find general use. It is probable that a more intelligent and liberal policy on the part of the holders of the monopoly of their manufacture will lead to a reduction of price to one-third the present tariff and still afford good profit, while so enormously increasing their use as to give largely increased dividends to their makers. Weights can probably be, in time, reduced to a fraction of those now usual and costs should not be more than double those of the raw materials of their manufacture, perhaps ten or twelve cents per pound for the cells.

The lightest batteries, to-day, store about 30,000 foot-pounds per pound; coal stores 10,000,000—of which, however, but about ten per cent. is thermodynamically transformable—and heated water stores about 15,000 foot-pounds. The heavy storage batteries of the market, proportioned for durability, store but

about 20,000 foot-pounds per pound weight. From one-third to one-half the total weight of the storage battery outfit, as commonly constructed, is acid, tank and lining. Both cell and accessories are undoubtedly to be greatly lightened with later improvement. The real question of interest to us now is to what extent we may be able to profit by such improvement, in the early future.

Just now we must reckon on a weight of not far from 70 per cent., as a maximum, of lead to cell-weight and 60 to 70 pounds of cell per horse-power-hour, stored in a space measuring not far from one cubic foot, minimum, one and a half as a maximum, per horse-power-hour; although automobilists' demands have, in special cases, brought the space down to a half cubic foot, and still less is promised. For similar quantities of power and work, at the point of application to propulsion, the storage battery has a weight of fifty to a hundred times as much as coal and demands from ten to twenty-five times as much space. If the comparison is made with the petroleums, these figures may then be decreased thirty per cent. Motors weigh about as much still be increased fifty per cent. Motors weigh about as much as steam-engines of similar power and their accessories: not far from the weight of boiler, or about half the total steam equipment. The key of the situation is thus seen clearly, so far as the utilization of electric energy is concerned, to be found in reduction in weight of battery. The success of this system must ultimately depend upon the ingenuity, judgment and learning of the electrician and the electrical engineer and on the broadness of policy of the manufacturer who, to promote his own success, even, must be wise enough to work also in this direction, and then to seek a wider market by contenting himself with a small percentage of profit—resulting probably in maximum dividends, in the end. To-day, the usual proportion of battery for 20 horse-power, four-hour discharge, would weigh about seven or ten tons and the light automobile outfit about three tons as a minimum, and half these figures would suffice for a two-hour discharge. But to do an all-day's work, as with steam, without recharging, would mean at least five times the last figure. The storage battery and its machinery of propulsion must be reduced in weight to a fraction of its best figures of to-day to do the work which can be readily performed by the heat-motors.

Costs being compared, it will be found that, the best work of the electric and of the steam-motor being assumed, the cost of the whole heat-motor equipment, ready for action, is, at best, about the same as that of the machinery of the electromobile and that the cost of the battery must be added as an excess-charge. We

may fairly anticipate that steam and other heat-motors may, in time, be brought into the market at a cost not exceeding, we will say, $50 per horse-power. Similar power in the storage battery itself, assuming a five-hour discharge, would cost not far from $100, as a minimum, and perhaps $200 as a maximum, and half these figures for a half-time endurance. The additional cost of the motors may be taken as about the same as a steam equipment as a whole, engines and boilers, or of heat-motors of other forms, complete.

But, notwithstanding the fact that the storage battery will now furnish but about one-thirtieth, at best, of the energy at the shaft of the best coal, or one-fortieth to one-fiftieth that of the petroleums, in equal weights, and that costs are enormously in favor of the heat-motors, the convenience, neatness and cleanliness, quiet, safety and handiness of the electric system—its whole operation, in fact, so far as applicable—are so nearly ideal that we must all hope most earnestly that weights and costs may soon be reduced to practicable quantities, and that stations for energy-storage may be soon established on all highways, as well as in every city. Meantime, it is very possible that electric energy-storage may find new forms, and who knows but that the result of further discovery and scientific investigation may be the artificial production of the equivalent of "ball lightning" in controllable form?

For the present, we must content ourselves with seeing two pounds of coal consumed in originating this energy where one would suffice were the steam-power producing it directly applied to the work to be done. Where weight and cost are not absolutely controlling quantities, the electric carriage is greatly favored, and Mr. W. K. Vanderbilt and his $5,000 victoria probably at the moment lead the procession. The smoothness of the motion of the motor-dynamo with its continuous rotation, its steadiness at whatever speed and its lightness—capable, however, of further and great improvement—tell strongly in favor of the electric vehicle.

The storage battery is in enormously extensive use on a large scale in power and light development in Europe and is rapidly coming into use in this country; but it is a vastly different problem where the storage is demanded for accumulation of energy for transportation while in process of application and the necessity of reduction of weight to a minimum is in the latter case incomparably greater, in fact absolutely essential to success. With the battery weighing ten times as much as its ideal prototype, the opportunity of gain in this respect is apparently very

great, and we will both expect and demand it for the automobile. The reduction already made, however, proves to be, largely, a reduction by sacrifice of life, and at increased cost, of batteries, and precisely where the best compromise between gain of weight and loss of money comes is difficult to determine.

The high efficiency of the storage battery is one of its most encouraging features. Professor Callender has found the ampere-efficiency to be as high as 96 per cent. and the watt-efficiency 84, and others have claimed still better figures. Costs of maintenance vary greatly, but the manufacturer of the standard battery guarantees to keep it down to four or five per cent. per annum. In the special automobile battery, the figure must be, naturally, higher. Ways must yet be found to produce a battery capable of larger storage than those of to-day, on lighter weights and, where needed, with quicker discharge, and all this with immensely increased economy of first cost and of maintenance. Weights of hundreds of pounds per horse-power-hour must be reduced to tens. Guarantees must be exacted of the maker, and carefully worded and as carefully lived up to or exacted. This system it was which first caused the entrance of the steam-engine-builder and designer upon the path of improvement which has been so marvellously extended during the latter half of the nineteenth century. The fact that the unpatented Planté type is free to all gives at least some opportunity to lead off to every inventor and independent maker. A guaranteed efficiency of 75 per cent. should be expected to-day, eighty per cent. should come very promptly and ninety per cent. in the early future. Prices falling below $100 per kilowatt should be secured and, ere many years, we may perhaps look for figures much less, a fraction of those of to-day. Where, as is actually the fact with some makes of battery, the product is already many tons a day—a firm of German makers was shipping sixty to seventy tons a day, some time ago—improvement should proceed rapidly; for the makers have in such case ample capital and opportunity for experiment. Once this work is fairly begun, the costs will drop far below those of to-day, for even large installation and stationary work, and $25 per kilowatt-hour may be looked upon as an enormous price. The best reported figures for cost of power, perhaps about two-thirds of a cent per car-mile, will certainly be greatly reduced ere long.

At present, it remains a very important fact that the energy-store in coal and the fuel-oils, by nature, is very much more compact and vastly less costly than the artificial storage of energy, developed by the heat-engine, converted into electric energy, and then stored in the accumulator. A cubic foot of coal in the

bunker represents, in fact, about 20 horse-power-hours, in the ordinary storage battery about one, and in the lightest of automobile batteries of the time, about 1.6 horse-power-hours. The motor weighs about 30 pounds, possibly in some cases a little less, per horse-power, or about the same as current torpedo-boat engines and double the minimum of our day. Professor Durand finds that the weights of battery required in such marine practice would be from three to five or six times the displacement of the boat, for a four-hour discharge, and for the now moderate power often adopted, 2,000 horse-power, and for the moderate speed of 23 to 25 knots. A four-hour range of steaming, say 100 miles, would, however, be an absurd limit for such craft. The costs of the two outfits, at present prices, would also be in the proportion of three or four to one, in favor of steam.

The development of the Planté type of battery, especially for automobile work, seems to give much promise, not only indirectly, as stimulating through competition the best and cheapest work of the patented accumulators, but directly as a type finding very satisfactory application to this particular purpose. Reduction of cost and increase in power for a given volume and weight will prove the one main line of improvement and the extension of areas of active surfaces, reduction of depth of active material, and decrease of weight and volume of inactive and simply enclosing and accessory metal, with promotion of circulation of the fluid in the cells and over the composition employed, will promote as actively the reduction to useful and available form the automobile storage battery.

The best action and highest efficiency will always be found to be that which makes the cost of power supplied a minimum, as a total, when all costs, direct and indirect, first cost, maintenance, replacement, wasted time and lost business have been made a minimum per unit of useful and paying work. In the automobile the item of cost which includes value of space and weight appears as an important factor where it does not enter to any important extent in common use for stationary work. Prices as well as costs are so liable at any time to suddenly and extensively vary that no figures can be given of more than temporary value; but the principles involved are always applicable by the thoughtful and intelligent engineer.

The whole business of design is always a compromise. It is possible, if the batteries, for example, are made large enough, to reduce costs of maintenance to a very unimportant percentage; it is practicable to secure small size and weight by adopting high rates of discharge and depreciation of the batteries; somewhere,

as always, the engineer must seek and if possible identify and adopt the golden mean. Improvements looking to extended and satisfactory use must, to prove satisfactory in themselves, be such as reduce costs of manufacture and of operation and use.

The latest and most promising figures for the storage battery of to-day are perhaps these: 6 to 8 ampere-hours per pound of battery, where the theoretical output for the ideal case and maximum efficiency is 96 per pound of lead-peroxide, and an efficiency, as thus measured, of about one-third, where the cell gives 33 ampere-hours per pound of peroxide therein. These figures are better by nearly a half than those of the average battery of the market.* This means either a corresponding decrease in the weight carried as load, in form of battery, or, with the same load, a doubled working range of action or radius of limiting route.

Vollmer reports that, in automobile work, the Planté type permits high discharge-currents without serious loss of efficiency. Fifteen minutes suffice for charging a battery of 80 ampere-hours, but the objections, in weight, volume and small capacity are important. The Faure type he credits with less weight and volume and a greater capacity, but a restricted life, where rapidly discharged, which puts it at a disadvantage in competition with the Planté. He makes the relative weights about as two to three or as three to four in favor of the Faure, and credits the two batteries with, respectively, 2.8 and 3.6 ampere-hours per pound. Capacities per cubic inch are given as 21 and 35 ampere-hours, respectively, and the length of route may be thus 15 or 18 miles with the Planté and between 25 and 30 with the Faure. The life of the former is about 200 discharges under such conditions and 120 to 150 with the Faure; the first being most suitable for city use and the other for long trips across country, and where economy is not a controlling consideration.

In handling the electric vehicle, the storage battery of to-day compels peculiar care in manipulation if its life is to be prolonged and maximum efficiency is to be attained. The speed and power, the latter, particularly, as measuring the draught upon the battery, must be made as uniform, *en route,* as practicable; the current should be taken steadily and never, unless in an emergency, in " flashes " or rushes; the fewer starts and stops the better and the more steady and deliberate the changes of speed the longer the life of the battery and its period of satisfactory action in any one run. The less the brake is employed, also, the better. The ammeter should be constantly in view and made a guide at all times, to aid in insuring the maintenance of the conditions of

* *Electrical World and Engineer*, April 28, 1900.

best effect of battery and motors, and their maintenance. Efficiency is lost with either overload of battery or overload or underload of motors. Normal speed and power continuously and uniformly maintained gives the best result. Batteries should never be completely discharged, unless a very serious emergency should arise, and should never be left completely discharged under any circumstances.

Properly constructed and applied and operated, it is asserted by those who have looked into the matter with care, that the storage battery can do work on the street railway at about half the first cost and half the operating expense of the horse-drawn street-car and this should be approximately represent the relative costs of the two motors, one would suppose, on the highway as well. In street-car practice, the relative weights of car and battery have been about 3.5 to 1 and occasionally as low as 2.75 to 1, where the vehicle is exceptionally light. With sealed rubber jars for automobile work, the weight of the battery is usually lighter than for the street railway and about 3.5 watts is reported to be the output per pound for a three-hour discharge. Where steep grades are met or much stopping and starting is requisite this weight of storage battery is often fatal to success.

The storage battery, although still the weak point of the electro-mobile, has been enormously improved in adapting it to this special and exacting purpose. Great gains have been lately made in its concentration of power, its strength and endurance, its safety, its steady pressure, and its capacity for rapid charge and discharge. With the rapid growth of the electric light and power distribution of the country and even amidst the sparsely settled districts, far from the great cities, facilities for charging are coming to be comparatively common, and this essential improvement is apparently keeping pace with the progress of the automobile itself. With the possibility, if we may assume it, of 5,000 charges and discharges in the life of the battery, it only remains to find a way of making the apparatus lighter, approximating its theoretical weight, without loss of permanence of structure, to give us a machine capable of almost unlimited employment about our cities and even in moderately long-distance work. Already its capacity is reckoned as about four times that of an equal weight of compressed air-storage, and the opportunity for gain is still enormous. But such extension of application can only come when ways are found to reduce costs very greatly. With prices ranging from $300 a ton, in large batteries, to $500 and even $1,000 and upward a ton for small sizes, this system must be seriously retarded.

Just as long as it costs so much and we secure such small returns in energy, the electric apparatus will be tremendously handicapped for all but a very limited range of application in automobile construction. As long as the lightest of storage batteries store but about three per cent. of the energy of equal weights of coal—measured as delivered at the shaft, at that—its use for commercial purposes must remain enormously restricted on land and absolutely prohibited on the water.

The fact that the storage battery has been very extensively employed in railway traction and yet has been in every case displaced again by either one or another of the various competing motors, is not to be taken as proof that it may not prove, in time, the ideal and the commercially desirable motor for the automobile; although undoubtedly it does prove the disadvantage of the accumulator where it is practicable to apply motive power from the primary motor more directly. Apart from weights and volume and cost, its action is ideal; but, unfortunately, volume, weight and cost are the principal obstacles to its introduction and precisely as they constitute objections to every motor in transportation, whether on land or sea. Yet, the experience had on street-car lines has shown that the average life of the battery has been, commonly, about 12,000 miles at best and, at a hundred miles a day, this would mean the replacement of the battery about once in four months. The best work, however, is reported at about 60,000 car-miles for the plates, meantime several restorations of the paste being needed, and this would mean a very great advance in recent practice. Dr. Ball's comparison, some years ago, showed the costs to be about twice as great for a stated amount of work with the storage battery as with direct systems.

The battery should give at least 1.2 watts per pound weight, should weigh not more than 300 pounds per ton transported, and the discharge should be at least, if needed, 0.60 ampere per pound. The storage battery, through increased weight, compels the use of twenty or thirty per cent. more traction power than other systems.

Costs of Operation of the automobile vary greatly, not only with size and duty, but with class, construction and management. It is as yet difficult to state what may be anticipated as a reasonable figure for the standard machine, of the immediate future, even. Tests by the British Automobile Club at Richmond have shown that heavy steam automobiles capable of taking up a load of 3½ tons and transporting it at considerably more than ordinary horse-transportation speed, cost, for fuel, about one cent a mile and the usual upkeep, on *all* accounts, is reported to be

about $2,000 per annum, amounting to about 3 cents per ton-mile, as against the reported cost for equal work with horses and wagons of 15 to 20 cents or more per ton-mile. In Paris, according to reports made to the *Société des Ingenieurs civils,* the electric cab costs an average of about $1.25 a day, for the current and storage, and $4 for all costs of operation; exceeding the cost of the older horse-drawn cab by 10 cents per day. Mr. Maxim's century run of 7 hours and 45 minutes cost $1.25 for his 190 ampere-hours of current used; costing, however, but 41 cents at the dynamo.*

Costs compared by Messrs. Simpson and Bodman, recently, are taken as about $300 per annum for 300 ton-miles of carriage, 300 days in the year; of which work two-thirds is taken as useful, the balance as "tare." Similar work by steam-carriage or wagon is estimated as costing about $95. The ordinary size of two-seated carriage having a speed on the level of about 15 miles an hour and a radius of action of about 40 miles on good roads costs, in the average case with reasonable care, not far from $25 a month for "upkeep." The storage battery and its care and use cost much the largest part of this amount and probably three-quarters in most cases.

In the rivalry between the steam and gas engines on a larger scale, the latter seems to be constantly gaining and, in costs, to be in many cases far in the lead. Recent statistics show that gas-power plants, in Europe, have been found to cost from $0.006 to $0.014 per kilowatt-hour, for the year reported on, and steam plants, for the same period, cost from $0.013 to $0.0142. At Dusseldorf, the costs are reported, for a lighting plant, with gas, as a half cent per kilowatt-hour. The improvements now sought are better regulation of the mean speed, more efficient fly-wheel control and reduction of noise and vibration. Adams reports that gas-producers and gas-engines give an economy of forty per cent. under stated conditions over the steam-engine.† On the other hand, a number of English gas-plants have, of late, been altered over to steam. It would seem that, on the whole, automobiles have given a better comparative record for gas and the petroleums—which are, in fact, of the same class—than has been reported in other departments.

In what will probably ultimately prove the larger and more important, if more commonplace, field of automobile transportation, that of commercial traffic and of the delivery wagon, paying work has long been done by the steam automobile and the other motors are now coming into sharp competition with that pioneer. This field is ordinarily urban; but it is likely that it

* Automobile Magazine, January, 1900.
† *Engineering Magazine.*

will extend greatly in the coming years. Costs of horse-traction have been reckoned, under the usual conditions of operation in the metropolis, as about 17 cents per ton-mile, where the not unusual case is taken of one ton total weight and a mileage of 20 per day. This figure may be reduced to 10 cents by employing two horses to increase the mileage of the single wagon to 40 miles per day. With a small business, in which the vehicle cannot be constantly employed, the costs of work accomplished will increase in proportion to the wasted time. The more continuous the use of the apparatus, as a rule, in all form of transportation, the higher the efficiency and economy.

Electric automobiles competing in such service as the above have been found to demand about 120 watt-hours per ton-mile, equivalent to one-sixth of one horse-power; although, as in all transportation, a surplus power is to be provided for emergencies, as a matter of course. The cost is about one-half that of horse-power, even less, often; both figures including wages and incidentals. The cost per pound delivered by each is computed as 0.168 cents for the electric apparatus and 0.178 for the horse and wagon. The difference in the two methods of computation, per ton-mile and per pound delivered, is due to differences in weights of vehicle and motor. The horse costs 90 per cent. of the total in the one case and the electric motor but 60 per cent. in the other. Exclusive of wages, costs of operation become $1.43 per day for the horse and $1.19 for the electric service—a saving of 17 per cent. for the latter. How far these comparisons will be affected by depreciation is as yet uncertain; but the depreciation of the horse and the wagon is always a very large figure, and very extravagant allowances may be accorded to the automobile to equal them. It is probable that the above comparison may be found, ultimately, to be less favorable to the automobile than it should be.* There is no expectation of reducing costs of horse-service, but no one knows how far the gain may prove to be increased in the improvement of the automobile.

With storage batteries costing, even for light and power station work, $40 to $120 per kilo-watt-hour at low and at high discharge-rates, respectively, and with ten per cent. depreciation, as reckoned by the majority of those investigating the subject, the field offered for improvement in this direction is obviously very extensive and attractive.

Costs of operation in the recent French competitions of 1898 and 1899, as reported to the *Société des Ingénieurs civils de France,** are not far different with steam, vapor and electricity.

* Operating Costs of Horse and Electric Delivery Wagons in New York City. By Messrs. Fliess and Sever, Trans. Am. Inst. Electrical Engineers, 1899.

Electric cabs with the Fulmen accumulator consumed 150 to 250 kilo-watts per mile at an efficiency of battery of 75 per cent. They carried batteries rated at 8 to 12 kilo-watt-hours consumption daily. Their consumption per ton-mile was from 65 to 95 watt-hours for the delivery wagon at 6.5 to 14 miles an hour and from 105 to 160, for the cabs at from 6.2 to 15 miles an hour. Daily costs on all accounts ranged from $3.75 to $4, of which less than half, often much less, was for the power. There was little difference among the several motors in this respect.

Standardization must be effected in the handling of the storage battery, from designer to manufacturer and from manufacturer of vehicle to user. The total watt-hours to be guaranteed should in some way be absolutely determined for all and the rate of discharge equally exactly guaranteed for the specific use to which it is to be put; which use should be understood distinctly by all. When one-half the weight to be transported consists of the battery itself, its exact adaptation to its purpose and a maximum of power and endurance become obviously vital matters, and its precise definition and guarantee no less important. Probably the production of standard and tested sizes of jar and of groups in battery would do much to improve the condition of the market and the use of the accumulator. It will then be at once possible to determine just what proportions of discharge-rate to storage and what proportions and methods of use will give the automobilist the most for his money—and this is, in the end, the problem in every commercial or industrial operation—and will perhaps promptly lead to the reduction of weights far below the 12 watt-hours per pound of active elements in the battery, considered the minimum at the commencement of the year 1900.

The Design and Construction of the Body of the Vehicle and of its running parts, in this country, has been considered by purchasers, abroad as well as at home, to be superior to any foreign manufacture, and the light and graceful American automobile finds a market throughout the world. The almost or quite entire absence from view of the machinery of these carriages and wagons is not only a recommendation from an aesthetic point of view, but also from that of the mechanic; for it means, in addition to improved appearance, a reduced liability to injury by dust and dirt from road and carriage body. All the pretty and comfortable and convenient patterns of carriage and wagon evolved through past decades for equine transportation of passengers and of merchandise have found equally satisfactory representatives in our latest constructions of automobiles, with, in some cases, such improvements in grace of form, convenience of operation

and comfort in use as only could be made practicable after the removal of the horse from before the vehicle. This freedom of design, so obtained, has not yet been fully availed of; but it is very certain that, ere long, the designer will discover his freedom in this respect and we shall soon see some admirably original, beautiful and handy carriages, constructed on entirely different lines from the horse-drawn apparatus, and as unique in their adaptation to their special purposes in use as in their suitability to the performance of good work.

The wheels and their details are coming to be made very solid and strong for the heavy commercial automobile, light, stiff and yet strong for the express vehicles, and, for high speeds and racing carriages, the highest skill of the designer and of the builder is demanded and secured. Ball and roller bearings may here find place, and every device for reduction of weight, of friction and of loss of energy or wasted power, in every direct and indirect manner, will be studied with a view to the application of concentrated power in largest possible degree to propulsion of a carriage of minimum resistance.

Resistance being reduced to a minimum, as far as is practicable, by reduction of the weights of carriage and machinery, the use of large wheel-diameters and of a tire of least resistance are the final expedients for improving the performance of the automobile, and the improvement of our roads and pavements then becomes the most important matter of all. On an absolutely hard and smooth road or pavement, the best tire-material would be found to be the hardest and smoothest of metal. Where large obstructions are to be overcome, the same statement probably holds good; but, for the ordinary highway, paved or not, the resistance to motion of the automobile is mainly found in small irregularities, in the uneven surface of pavements and in the yielding of the roadbed or in the presence of pebbles of comparatively small size, and here the rubber-tire comes into play with great advantage. The minor obstacles imbed themselves into the tire and it rolls on at an undisturbed level and without that serious waste of power, due to the rise and fall without restoration of energy, which ordinarily produces such great waste and resistance to the wheel tired with an unimpressionable material. Experiments at Sibley College on bicycle-tires have shown clearly that, other things equal, the thinner the tire, the better it is expanded, the more permeable its surface and the more impermeable its body, the better the work on the ordinary road or elsewhere. For heavier vehicles, where considerable weight must be carried, and therefore a heavy tire necessarily employed, if

pneumatic, a compromise must be felt out for each line of automobiles, light and heavy, racing and other, between efficiency in this respect, the costs and the risks of puncture. With improvement of roads and street pavements the problem of the tire will probably, in time, completely solve itself and the vehicle will do good work with the more durable forms.

The Materials of the Coming Automobile must include, probably, new steels for strong and elastic parts, making axles and springs of indefinite life with lightness, strength and high elastic limit and with proportional moduli of elasticity and range of flexibility and ductility. For the wagon-body and accessory parts, woods, like East Indian teal and our own ash and white and yellow pines, combining lightness, strength and elasticity and large range of yield—the ideal yew-like material for archers' bows or a carriage-bar—will find place in the construction and will lead to corresponding improvement of every older form of carriage and railway vehicle. New alloys, very possibly—as, for example, the "alzinc," used so extensively in Sibley College work for such cases—may prove available for castings, giving admirable combinations of lightness and strength, and other kinds for "running parts," where the highest possible strength is demanded at whatever cost, are certain to find prompt adoption into this system.* All advancements in aëronautics and in marine, torpedo-boat, engineering will afford suggestions for the automobilist and help on his progress. Invention and discovery, science and all arts, the brain of the man of science, the hand of the mechanic, the genius of the inventor and that of the engineer, will alike conspire toward a common end—the improvement and the successful introduction, for all its many purposes, of The Coming Automobile.

To-day, cast-irons, made in the air-furnace, may be obtained with a tenacity of above 30,000 pounds per square inch; cast steels may be made of from two to five times that strength, according to proportions of hardening elements, and steel castings replacing those of iron may be purchased with resistances and ductilities enormously exceeding those of cast-irons. Wrought

* Alloys of possible value, especially for castings, have sometimes been discovered in the course of research in the Mechanical Laboratory of Sibley College. Thus: "Alzinc," as it has been generally termed, consists of two-thirds aluminium and one-third zinc. It has the general working quality of a very good cast-iron, but has only about four-tenths its weight (S.G. 2.9), works beautifully in the lathe and on the planer, and can be cast very fluid at a comparatively low temperature, making remarkably sound and even castings. Its tenacity is about 25,000 pounds on the square inch, and, when warm, it is ductile, but it is brittle at low temperatures. Its cost is about two-thirds that of aluminium. Another alloy, "alzinctin," contains 50 per cent. aluminium, 25 tin and 25 zinc. Its specific gravity is 3.17 and its cost is about 80 per cent. that of aluminium, a trifle higher than the preceding. It has a measured ductility, even when cold, about 5 per cent., and is a better material for smaller parts and where some ductility and elasticity are desirable. Its tenacity is about 20,000 pounds per square inch. Both alloys, at the boiling point of water, become very much tougher and more ductile. No copper can be employed in making these alloys, as it proves wholly deleterious.

irons in bars of good quality have tenacities of from 50,000, as in bridge-irons, to 60,000 and over with harder, and 70,000 with cold-rolled irons, and, in rods and wires, having increasing tenacities with decreasing sizes until 150,000 pounds and more may be had in the smallest sizes. In steel, these figures are much exceeded and wire of about 175,000 pounds tenacity has long been obtainable for bridge-construction and special qualities, like, for example, that going into the best of the fine and high-grade watch-springs, have been brought up, in these very small sections, to 300,000 and even, occasionally, to 400,000 pounds per square inch.

Lightness of Construction is usually a valuable property in our moving machinery and especially for that of transportation. The product of the inventor and mechanic, of the man of mind, has now come to enormously excel, in this respect, that of nature. The common draught-horse weighs about one ton per horse-power and probably rarely, if ever, works by the day at much less than that figure. Man, if strong and muscular in exceptional degree, may perform his day's work at a weight as little as 750 pounds per horse-power; probably oftener at double that rate. Stationary engines weigh 500 to 1,000 pounds per horse-power. The locomotive weighs from 100 to 150 pounds per horse-power; the marine engine rarely falls below that weight, except in the special cases of torpedo-boat and fast yacht construction, where the weights are brought down, often, to 60 pounds, sometimes to 40, and rarely to 20 or even 15, while the aëronaut halves even these figures on rare occasions. The birds are reported to practically duplicate them; notwithstanding the fact that the animal muscle seems to be subjected to a load of but a small fraction of that carried by the metal parts of mechanical motors.

For the purposes of automobile construction, as well as for aërostation, the true gauge of the value of a material for use in the structure is best shown by its capacity for carrying its own weight, rather than simply by its tenacity as usually reported. It is of no advantage that a substance should have double the tenacity or compressive resistance of another if it also weighs twice as much. The length of rod of uniform section that may be carried by any substance, when suspended from one end, is the real measure of constructive value for our proposed use, assuming that the material is of the desired class for our immediate purpose. Thus: good cast-iron will sustain over two miles, say 12,000 feet, if made in the air-furnace or the best ordnance iron. Common bronze carries a trifle more, perhaps 14,000 feet.

Good wrought iron, of 50,000 pounds tenancity, will thus support 15,000 feet, nearly three miles, and in small wire double that length. Steels of eighty, a hundred and a hundred and fifty pounds tenacity per square inch, will, respectively, support four, five and seven and a half miles of their own material in form of a prism suspended by one end. Aluminum supports about four miles and some of its alloys double that length. Fine watch-springs may be found equal to the load of fifteen miles of their own section. Aluminum and magnesium, the two promising new metals, seem likely to provide alloys capable of substitution with advantage for the now usual cast metals, but not probably to replace the steels in malleable work. There is here, however, a very important field for exploration. It may probably be asserted that any material incapable of sustaining at least two miles of its own section in the form of castings or four miles, forged, is not to be considered particularly desirable or promising as material for use in automobile construction, where the aim is the production of a machine combining minimum weight with strength and safety.

The Limiting Value of the Materials of Automobile Construction may thus be taken as not far from 10,000 feet, as above gauged, for castings and 20,000 for forged parts in metal. Otherwise stated, the quotient pounds on the square inch divided by weight per cubic foot should exceed sixty ($t/w > 60$) for strong castings and should be above 120 if not 150 for forgings. Gun-iron and tool-steel will come into use in the finer constructions and probably some of the new alloys, as nickel-steel and those of aluminium.

Hemp rope and similar fibres are comparatively weak and carry but about two miles of their own section. Good fishing cord carries, if of best linen, about eight miles and, in tension-parts, is thus superior to iron and the soft steels and to aluminium. Silk may sustain a length of nearly thirty miles and is, in turn, vastly superior to linen and, in fact, to all organic material available for similar purposes. Catgut sustains five to seven miles, rawhide about three and "sinew" about the same as silk. These strongest fibres are equivalent, in tension, to steel of about 100,000 pounds tenacity or something over. The woods of best class have values of $t/w = 250$ or more, as a rule. Ash gives $t/w = 350$ and hemlock may rise to $t/w = 450$; the range being equivalent to that of steels of from 125,000 to 200,000 pounds tenacity. Hickory stands about at the upper limit, with the strongest steels of ordinary character. Copper, tin and zinc, unalloyed, have no attractions for the engineer-automobilist.

Success in the improvement of the details of construction evidently depends largely upon discretion in the choice and use of the materials of construction, and one important path to further progress lies in the direction of further exploration of the field for new metals and especially of new alloys.*

Requisites—Positively certain and safe operation, automatic just as far as possible, is evidently one of the desiderata with the automobile. Its essential characteristics, if it is to be successful and permanent, may perhaps be thus summarized:

(1) The automobile must be safe, comfortable, convenient, handy and quiet, light and strong, easy of maneuvering in forward or backward motion, powerful at low speeds when ascending hills, capable of attaining comparatively high speeds on smooth, level roads without jar or vibration or excessive expenditure of fuel or energy, and must please the eye as well as the judgment, and a sense of fairness as to cost.

(2) Its action must be, in largest possible degree, automatic, and it must be capable of being handled safely and satisfactorily by the average user. It must be simple and not liable to become disabled within a reasonable period of working life, easy and inexpensive of repair in case of a breakdown, readily adjusted as to speed on any road or any incline, with a brake capable of, if necessary, skidding its wheels—but no more—and capable of going over rough country without danger to carriage, machinery or people, and with positive advantage to the roads.

(3) It should be odorless, as well as noiseless, prompt and certain in starting, easy, and as prompt as the emergency may require, in stopping. It should have a good surplus of both impelling and stopping power. It must be free from danger of fire, explosion or breakdown of the running parts of the carriage. The latter should have maximum factors of safety.

As to our position to-day—Probably no one familiar with the situation and with the construction and the use of the automobile as now supplied the market, and as used by the automobilists of the closing year of the nineteenth century, will hesitate to assert the full demonstration of the following points:

(1) Automobile operation may be safely effected and no greater dangers attend it than are accompaniments of horse-drawn vehicles.

(2) Speeds may be attained, and maintained, higher than can be either attained or maintained by horse-power—doubled speeds

* Notes on Materials of Aëronautic Engineering; Proceedings of the International Conference on Aërial Navigation; Chicago, 1893, R. H. Thurston.
Materials of Engineering; 3 vols., 8vo., R. H. Thurston; New York and London, J. Wiley & Sons and Chapman & Hall.

for short distances and trebled for long distances. Length of route may be unlimited.

(3) Heavy gradients may be surmounted and any road fit for horse-drawn vehicles may be traversed by the automobile.

(4) A good construction of automobile machinery in proper hands—not necessarily those of a skilled mechanic—is, on the whole, much less liable to serious disability than is the horse. The better and more expensive the automobile, the less this liability to invalidism; the more valuable the horse, the more is he liable to injury and illness.

(5) Costs of maintenance and operation are less with automobiles than with equine outfits. With heavy work, the difference is immensely in favor of the automobile.

(6) Commercially, the well-built horseless vehicle, of whatever class and in whatever line of work, is greatly to be preferred to the horse and vehicle and its accompaniments of stable, attendance, untidiness, unsanitary conditions and obtrusiveness.

(7) There are no serious objections to the general use of the automobile for either heavy or light, slow or speedy, traffic. There are fewer and less serious objections than were raised to the introduction of the street-railway; while there is open to them an enormously more extensive field.

(8) The tires of the automobile, if not pneumatic or of rubber, may be made of any desired width and, of whatever breadth, will aid in the improvement and permanent maintenance of the roads, while the hoofs of horses injure them.

(9) Weights of automobiles, for similar powers and loads, may be made less than the weights of horses with their vehicles.

We may probably hope to be able, ere long, to say that prices of automobiles of similar speeds and loads may be made less than those of the equine outfit.

Whichever of the now more or less successful among the existing systems of automobile be adopted for the specific work to be performed, the advantages of the automobile over the horse-drawn vehicle are unquestionable. These advantages are, in general:

(1) Reduced cost of transportation.
(2) Greater speed and better control of speed.
(3) Absolute docility.
(4) More perfect "handiness," as a naval man would say.
(5) Sanitary gains of very great importance.
(6) Less cost of maintenance of pavement and roads.
(7) Less trouble in crowded city streets from interruption of traffic, as a consequence of the less space occupied and better action of the automobile.

(8) Much greater quiet, especially in traversing paved streets covered with cobblestones or brick.
(9) Reduced space and cost in storage.
(10) Extinction of the nuisance and costs of the stable.
(11) Abolition of danger from "run-aways."
(12) Continuous decrease of costs, as against steady increase with horses.
(13) Resultant upon the introduction of the automobile, to the exclusion, largely, of the horse, will come such improvement of our city streets and country roads as has only been just begun by the bicycle and its friends, improvements particularly adapting them to the new vehicle.

The automobile is the coming feature of our modern life. The bicycle has had its period of rapid development and of popularization, and the automobile is its natural successor. The bicycle is coming to be the every day instrument of business and pleasure. The day of excitement and of hysterics has passed with it, and we are settling down to its sensible but limited use. The automobile is a vastly more important development and it has an immensely larger and more serious and extensive field before it. The "wheel" has taken its place among the common necessaries of every-day life and largely passed out of the field of the "fad," pure and simple. The automobile is coming in to take up a great work and one of much larger range and higher importance. It is bringing to the aid of transportation of all kinds, light and heavy, passenger and freight, work and pleasure, the aid of the inventor and of the motor-machine. It is adapting itself alike to the demands of the rider in the park and of the tradesman sending home the family dinner, to the needs of the delivery wagoner and of the postman, to the transportation of tons of ironwork and of ounces of lingerie, to the slow traverse of the ploughed field or the deliberate movement of the "auto-van" and as perfectly to the express-speed of the racing vehicle over the one-mile track or over the hundred or the thousand mile course. Pleasure, convenience, business and public advantage, and all industrial economies are about to be promoted by its evolution, as power, speed and safety and handiness are gained, and costs are reduced in construction and in operation.

The horse will be relegated to a narrower field of work, and our streets will, in time, become as perfect sanitarily as they are coming to be, in well-managed cities, in their construction. The run-away horse, the constant source of anxiety and frequently of actual danger in the city street and in the parks, will disappear,

and the lives of mothers and grandmothers will be rendered thus more serene. Ericsson's automobile fire-engine of 1860 will have many useful successors. Cross-country routes will gain in attractiveness while losing the risks of ordinary coaching, and the hamlets and farms off the line of the railways, among eastern hills and on western prairies, will become accessible and comfortable as homes and pleasure resorts for all seeking the quiet of nature and the pleasures of country life, as well as for their native workers and the small farmer or the retiring millionaire. Hauling lumber, transporting ore, carrying merchandise over the common highway, delivering the morning purchases in the city, driving in the country or through the park and going to the opera in the evning:—each use will find its best and most satisfactory form and type and special construction, and the civilized world will be transformed through another and hardly less wonderful evolution than that which, in the field of railway and steamboat transportation, has characterized the century just expired.

Inventors and inventions of the older sort, amateurs in science and art, and a spontaneous inspiration, are now nearly gone by. The invention of to-day is simply a design adapted to a precisely defined purpose by a trained designer, familiar with the principles and practice of his art, who proceeds, by direct and safe and certain routes, to his end, adapting a mechanism of as exactly defined plan and method of operation to the work. The educated and professionally-trained designer has succeeded the ignorant, but often marvellously skillful and ingenious, inventor, whose crude devices required months and years, often, of experiment, trial and error, to work into practically useful shape and profitable form. To-day one trusts no inventor, if he lacks that scientific knowledge which is essential to success as a designer. It is the expert in the field in view who, to-day, determines just what to do and in what manner to reach the desired end. Every successful professional is a specialist and each is compelled often to say—as did a distinguished surgeon when I once asked him a question requiring special knowledge for its answer—" I cannot tell you that—*but there is another man who can!*"

But the man who can say just what is to be the future of the automobile, what form of motor, if any, is to be the one exclusive motor, or what will be the ultimate distribution of work among the perhaps various permanent types of horseless vehicles has not yet appeared. Only this can be said with probable truth: The steam-engine is not likely to see any very great advance in the immediate future and is too near its practicable limit of perfec-

tion, probably, to have much chance of success if that success depends upon extensive improvement in construction and type or in thermodynamic perfection. The internal combustion engine has a wider range of possible improvement, and to this extent has larger promise, but with no certainty, that its defects will be removed at any early date. The storage battery and electric propulsion have a similar relation to the steam-motor and, like the gas-engine, await the genius who can reduce still serious infirmities and give a very reasonable degree of approximation to the ideal prototypes.

The Trend of Progress of the Automobile, in all directions, is toward perfectly well-understood and fully recognized ideals and limiting perfection and the educated, professionally well-informed and experienced engineer will undoubtedly find many ways of pruning away defects and of importing improvements until that limit of practicable and economic advance is reached for each of these interesting types of self-propelling vehicles. This is not the work of the amateur in any line and the day of the self-appointed promoter of great advances in the industrial arts has gone by, never to return.

The Automobile Girl

Another bright meteor flashes across
  The skies of this workaday world;
Of all the dazzlers she soon will be boss—
  All rivals from power will be hurled!
She's trim as a two-year-old running on grass,
  A picture from summit to heel,
That fearless, intrepid American lass,
  The girl on the automobile.

She handles the lever with delicate skill,
  Sits straight in her seat as a queen,
She skims the smooth levels and scales every hill
  With ease on her silent machine.
Her eyes are a-sparkle with jolly delight,
  Her song has a silvery peal,
As onward she speeds in enjoyable flight,
  The girl on the automobile.

The fellow she honors with place at her side
  To take a spin over the street,
Swells up like a toad on a log in his pride,
  As stiffly he sits on the seat.
He knows he is stared at by all of his crowd,
  Can picture the envy they feel
To see him enthroned by that maiden so proud,
  The girl on the automobile.

Ye sweet cycle fairies with skirt split in twain,
  Your It-ness is waning at last!
Ye maidens who drive tailless horses, your reign
  Will soon be a thing of the past!
You long have been held as the cream of your sex,
  But now in this new-fangled deal
You'll get the keen gaff in your beautiful necks
  From the girl on the automobile.

Social Aspects of the Automobile

By Sylvester Baxter

THE automobile has a unique social record among improved transit instrumentalities. At the very outset it leaped at once into high social regard. The horse, the source of chivalry and inseparable from the idea of knighthood, was at once suplanted in the favor of aristocracy by his mechanical rival. In France the Automobile Club straightway vied with the Jockey Club as a great social organization and as the gathering-place for *la haute société,* becoming not only a markedly aristocratic organization, but even a centre for the reactionary elements in the recent scheming and plotting against republican and democratic tendencies in the government.

It seems very strange that one of the most important instruments of modern progress should start out with such associations. But "motor-sport" is the rage of the day, and as the golden youth of centuries past used to put on their coats of mail, mount their steeds, and go forth to the tournament, so their successors of to-day don garments that give them the aspect of common mechanics, with overalls and oil-cloth jackets, and race over the highways on their motocycles, voiturettes, or automobiles at reckless speeds that rival the railway express. Like the sports of chivalry, the new pastime requires courageousness and coolness, but more than those, it demands a mental equipment and physical training in accord with the spirit of the age—an adequate knowledge of mechanical science, together with a technical experience in which the oil-can and the monkey-wrench have taken the place of the sword and the lance. It is, therefore, significant that in its pre-eminently aristocratic phase the automobile should exhibit a socially leveling trait; making the very attributes of the trained mechanic those which are most necessary to proficiency in its use.

Other instrumentalities of progress in transportation have both their aristocratic and their plebeian phases. The railway, for instance, has its private cars and first-class coaches, its immigrant trains, and its third-class accommodations. The bicycle had a gradual development; at first an athletic device and an instrument of popular sport, it suddenly sprang into the highest fashionable favor, and is now a universal convenience, its use an

accomplishment almost as indispensable as a knowledge of how to walk. The automobile will inevitably have its broad, utilitarian phases; the high social favor in which it now stands in the days of its beginning will undoubtedly continue, but it will be insignificant in comparison with its manifold services in many other ways. The reason for this remarkable social regard may easily be seen. It lies very largely in the great cost of motor-vehicles in their present stage of development. There is an enormous demand for them, and the supply is exceedingly limited. So only those who can afford to pay high prices can obtain them. They are at present a luxury. Their cleanliness, their ease, comfort, and rapidity of motion, make them particularly desirable, and at present their possession and use is a mark of social distinction.

In time, however, the social monopoly of the automobile must give way to the demand for its universal use. This demand will be met by the increasing facilities of production which will suit all tastes. As with the horse and carriage, the most luxurious forms will supply the requirements of the wealthy, while good vehicles will come within the means of the moderately circumstanced, including a large constituency for whom the keeping of a horse and carriage is too expensive a luxury. Therefore, notwithstanding its distinctively aristocratic advent, the automobile will become one of the most powerful of social levelers. But its effect will not be that of leveling down; it will level up, by building a strong course in the structure of modern civilization, with its diffusion of comfort, its abatement of the gigantic nuisances that proceed from animal traction, and the development of better and more convenient ways of life and superior means of intercourse in both city and country. Like all other advances in invention, its tendencies will be distinctively toward democracy.—New York *Home Journal*.

MODERN IMPROVEMENTS

WRITEM—Young Rimer is an up-to-date poet.

REEDEM—How's that?

WRITEM—He says his Pegasus is an automobile.—*Baltimore American*.

Mechanical Propulsion and Traction

By Prof. G. Forestier

Sixth Paper

LET us now pass to the four-wheeled carriage. This consists essentially of a frame or of a body resting upon a rear axle and a fore-carriage, and connected with the former in an invariable manner. The mode of attachment of the frame to the fore-carriage permits the latter to assume any posi-

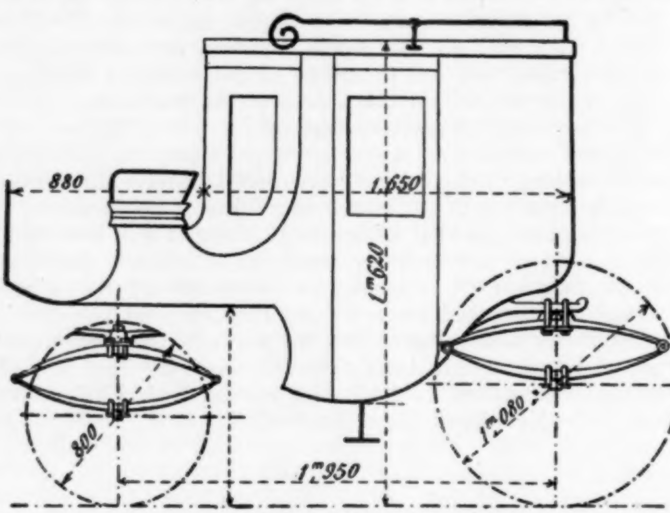


Fig. 23. Carriage for Passengers and Baggage

tion whatever with respect to the body. It is upon the fore-carriage that the motor acts.

The suspension of the fore-carriage and of what is interposed between the frame and the hind axle, we shall have to examine separately.

Concentrically with the king pin, the fore-carriage is provided with a " fifth wheel," consisting of two circle-irons, one connected with the frame and the other with the axle. It is evident that

these two irons must remain in one plane in order that their relative motions may take place without any difficulty; and such a condition must be assured by the suspension of the fore-carriage. Moreover, the suspension must, as in the two-wheeled vehicle, protect the living motor against the jerks that result from the shocks of the wheels against the projections of the roadway.

We represent herewith (Figs. 23 to 26), by way of example, a few vehicles that form part of the rolling stock of the Compagnie d'Orleans. The elliptic springs of Figs. 23 and 24 are adapted for light carriages only, since they are incapable of keep-

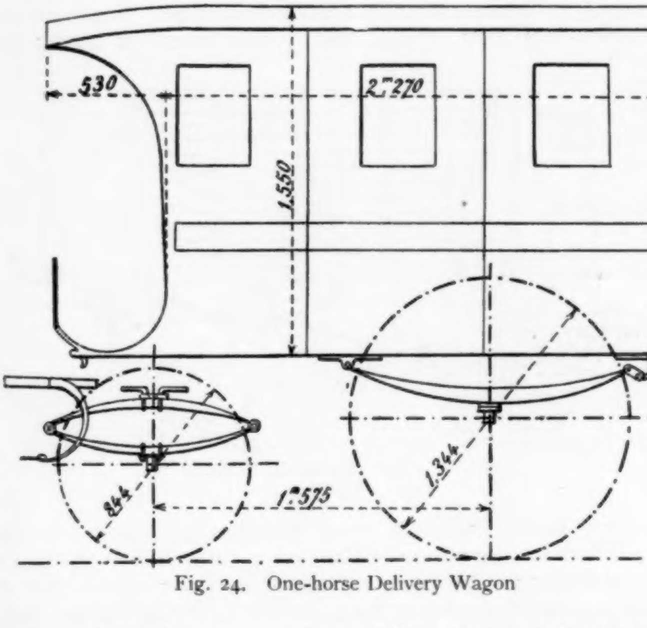


Fig. 24. One-horse Delivery Wagon

ing in a plane the plates of the fifth wheel, which is liable to buckle, owing to the fact that it is supported by two diametrically opposite points only. Moreover, they present here again the same drawbacks that we have pointed out in speaking of their use in two-wheeled vehicles.

The longitudinal springs of Figs. 25 and 26, fixed by their front extremities to the frame of the fore-carriage, and provided at their posterior extremities with a transverse spring, the centre of which supports the extremity of the said frame, completely assure the keeping of the fifth wheel in a plane, since there are

always three bearing points. Here, since the traction of the motor is exerted upon the anterior extremities of the longitudinal plates, such extremities must be assembled with the frame by a roller.

As regards the suspension to be interposed between the carriage and the rear axle, there are two cases to be considered—one in which the vehicle embraces a straight frame placed above the axles (trucks, delivery-wagons, omnibuses, etc.), and the other in which it is provided with a body of a more or less elegant form descending between the axles.

In the first case, for the suspension in the hind-carriage, we have merely to imitate that in the fore-carriage. Such suspension is shown in Figs. 25 and 26. Nevertheless, in trucks that

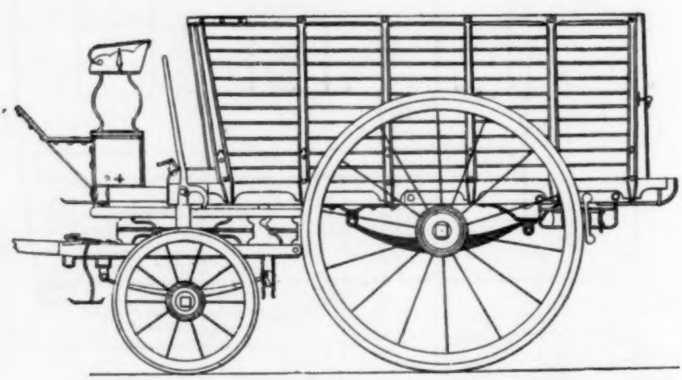


Fig. 27. Four Wheel Coal Wagon

are to carry heavy loads, no transverse spring is placed in the rear, and there is only a longitudinal spring attached to the frame through a roller at the front extremity, and through a link or some other movable device at the posterior extremity (Fig. 24).

In the second case, the usual custom is to transmit the traction to the hind-axle, either through elliptic springs (which have the special inconvenience of permitting of vertical oscillations only), or through bow-springs, which, contrary to the arrangement found in the preceding carriages, carry transverse spring-plates at the front extremity of the longitudinal plates. It is the posterior extremity that is fixed directly to the body and transmits the traction to the axle by compression.

In certain fancy carriages, the back spring-plates, instead of being connected by a roller, are joined through links. The

upper plate is then curved, and this increases its alterability of form (Figs. 29 to 32).

In a light carriage, upon a road in a perfect state, such an arrangement is acceptable; but an æsthetic arrangement of this kind for vehicles that carry heavy loads would be inadmissible.

In vehicles that carry heavy loads, such as coal wagons, for example, the posterior extremity of the spring-plate is free, as in the hand-carts already mentioned, and bears upon a metallic piece fixed to the frame and provided with cheeks to prevent a lateral motion of the spring (Figs. 27 and 28).

In former days, the old-style coaches, with their swan's-neck

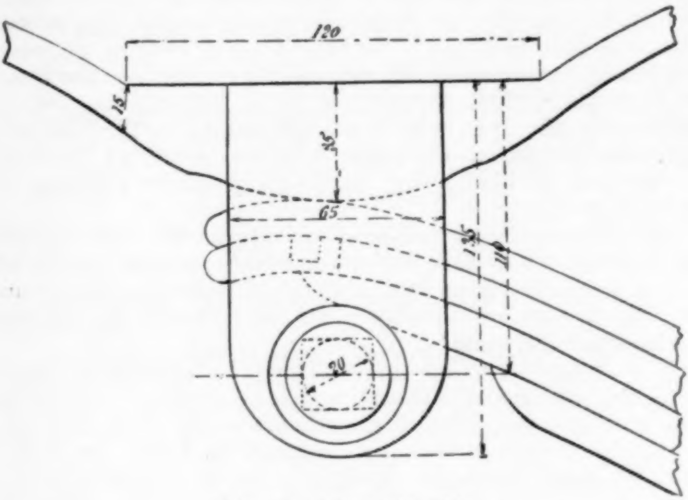


Fig. 28. Spring with Slide

springs, from which the body was suspended by straps, completely satisfied the object of suspension; but then, in order to assure the transmission of the traction of the team to the hind axle, the two axles were rendered interdependent through a rigid frame. This frame, the axle and the wheels constituted a very heavy combination of which the inertia was unfavorable to the draught. Such an inconvenience is still presented in mail-coaches, which have an analogous mode of suspension.

By adopting a properly jointed system for the frame, some manufacturers have got rid of the inconvenience of the interdependence of the four wheels, and at the same time have preserved all the advantages of the sensible mode of suspension, viz.,

transverse springs in front and swan's-neck springs behind (Figs. 30 and 31).

In automobile carriages in which the transmission is effected through chains, the transverse oscillations must not be too much facilitated for fear that the chain may be too easily thrown off the sprockets, especially in changes of direction at a high speed. To prevent such accidents, however, the gearings might be provided with cheeks to form a guard.

In a study of the suspension of automobiles, the position of the driving-wheels must not be lost sight of. If they are in front, everything that we have said concerning the horse-drawn four-wheeled carriage is applicable to the suspension. If they are in the rear, in order that the spring-plates may transmit the propulsion to the body and then to the front axle, in working by extension, it will be necessary, through rollers, to attach to the frame the back plate of the spring fixed to the driving-axle, and, on the contrary, the front plate of the spring fixed to the fore axle. The links should, in the same way, be placed at the front extremity of the hind spring and to the posterior extremity of the front spring.

When we come to speak of driving-wheels with movable axle-journals, we shall be led to ask whether manufacturers are not too much the slaves of a predilection contracted for animal traction. We are led to propound the same question here apropos of suspension and axles.

It is expedient, moreover, to distinguish two cases: one in which the carriages are light enough to be provided with elastic tires, and the other in which the vehicles are heavy and have to be provided with iron ones. As regards the latter, the experiments of Dupuit permit of no doubt as to the propriety of continuing to interpose springs between the axles and the frame, so as to diminish the non-suspended mass. On the contrary, as concerns the former, especially those of which the wheels are provided with pneumatic tires, that is to say, the weight of which does not exceed one ton per axle, would not the logical consequence of the use of pneumatic tires be the doing away with axles, the fixing of the journals directly to the frame, and the interposition, between the latter and the body, of the transverse springs necessary for the comfort of the passengers?

We should thus peculiarly facilitate the transmission between the motor and the wheels, which would form an invariable whole.

The transmission of motive force to the axle hauled or propelled would then be no longer effected except through the intermedium of the springs; and it might be easily possible to adopt

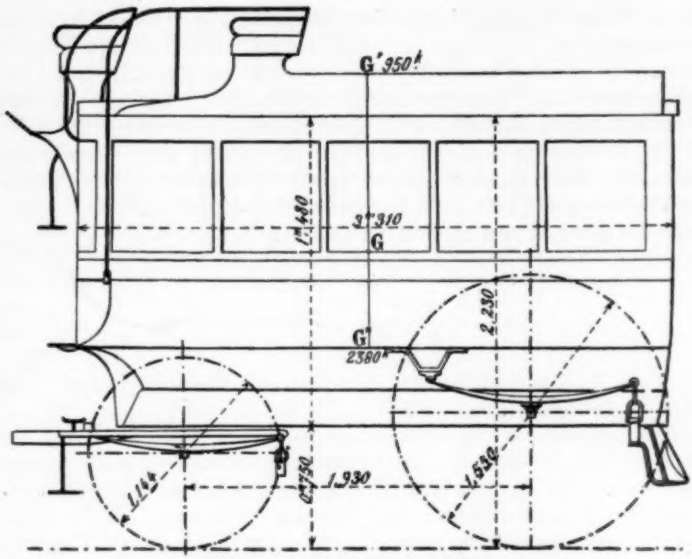


Fig. 25. Two-horse Omnibus

for suspension the arrangement best adapted for the object to be attained.

In certain American carriages with wheels provided with metallic spokes and pneumatic tires, the electric motor is carried directly by the driving-axle. The frame that connects the two axles rests upon them without the interposition of springs, and the body alone is spring-supported. In the first type, the method of attaching the transverse springs did not permit of any variability in the length of the plates; but in a new type now under construction at the Clement establishment, this defect will be corrected.

VIII.—Experiments to be Made.—We have already stated that the calculation of the power necessary for a motor to possess in order to impart a given speed to an automobile vehicle is somewhat imperfect in the absence of a precise determination of the numerical coefficients that enter into the formulas of the various resistant forces. We believe it to be expedient to say a few words as to the experiments that it would prove of interest to make in this connection.

(a) *Coefficient of Friction of the Axle-Journals.*—In a communication to the Academie des Sciences,* six years ago, M.

* Comptes rendus, 2d semestre, 1884, p. 861.

Marcel Desprez pointed out the method to be pursued in order to measure the coefficient of friction of axle-journals in their boxes. It is only necessary to raise the carriage, remove the driving-chain and give the wheel suspended in the air a rotary motion of which the velocity is determined by counting the number of revolutions made in a given time; and then to take the number of successively decreasing revolutions that the wheel, when left to itself, effects in the same period of time.

In fact, we have for φ the relation:

$$\varphi = \frac{p^2}{gr} \frac{d^2 \alpha}{dt^2}$$

in which p is the radius of gyration of the wheel, and r the radius of the wheel.

The decrease in the velocity is feeble enough to allow the differentials to be replaced by the seconds differences without sensible error. So, it may be said that the coefficient of friction φ is sensibly proportional to the seconds differences of the mean velocities during 30 seconds, which may be easily obtained by counting the number of revolutions of the wheel during this period of time.

If, at the beginning of the experiment, we give the wheel a velocity corresponding to speeds of translation of 4.25, 4.8 and 5.4 miles an hour, we shall probably find a very rapid decrease in the number of revolutions of the wheel, since, at this moment, the sliding friction of the axle-journals does not alone intervene, there being likewise the obstacle that the air opposes to the motion of the spokes, rims and tires.

After the velocity has become sufficiently reduced to make this cause of retardation disappear, it will be found that the coefficient of sliding friction will continue to diminish in measure as the velocity diminishes, and that, too, so much the more quickly in proportion as the axle-journal is better lubricated.*

There will be an abrupt increase toward the end of the experiment, because at this moment the lubrication will be less perfect.

If the experiment be renewed in simply throwing the motor out of gear, but in leaving the wheel connected with the transmission, we shall obtain a new coefficient, φ^1, which, through its difference from the first, φ, will make known the loss occasioned

* There might seem to be a contradiction between this increase of the coefficient of friction as a consequence of incomplete lubrication and the increase, with the speed, of the coefficient of friction in the case of a too abundant lubrication. But such is not the case. The coefficient of friction between lubricated surfaces is always inferior to the coefficient of friction of the same surfaces dry; but the difference continues to diminish in measure as the velocity increases.

by the friction of the various parts of the transmission at the different velocities of the wheel.

(b) *Measurement of the other Resistant Forces.*—For ascertaining the value of the other resistant forces that oppose themselves to the motion of the carriage, the experiment is not so easy.

The carriage under experiment may be drawn through the intermedium of a dynamometric apparatus. In most cases, the apparatus employed in experiments of this kind are derived from the Morin registering device, which, being well known to every one, we shall only briefly describe. It consists essentially of the following parts:

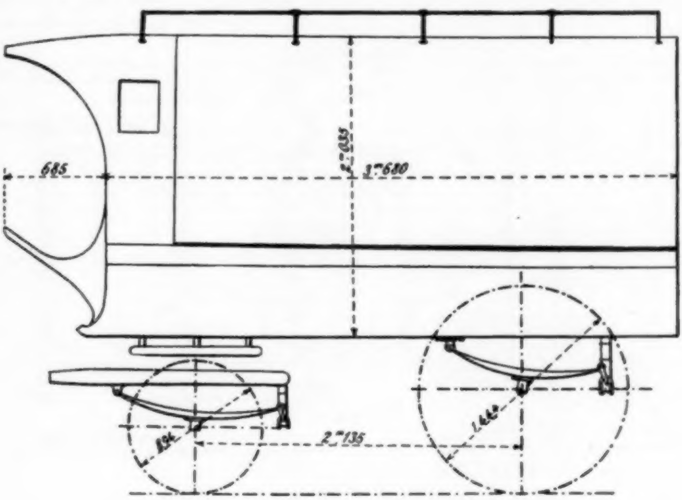


Fig. 26. Two-horse Delivery Wagon

1.—Of two spring-plates, *A B* and *C D*, properly connected by links *J* and *J'* at their extremities. One of the plates is fixed by its centre to the frame of the carriage, while the other is provided at its centre with a coupler, *P*, to which the motor is attached. The distance between the centres of these two plates is sensibly proportional to the static stress that is exerted upon the coupler.

2.—Of a registering apparatus formed of a band of paper which unwinds at right angles with the direction of the displacement of the movable plate of the dynamometer. To the centre of the plates are fixed pencils or styles. One of these, *R'*, fixed to the stationary plate, draws a straight line, while the other, R'',

fixed to the movable plate, draws a sinuous one. The distance between corresponding points of these two lines gives numbers proportional to the static stress at the time of taring the instrument.

In order to produce a regular unwinding of the paper, the best of the apparatus among those that have been experimented with seems to be the one devised by M. Paul Richard (Fig. 33). This consists of three cylinders: (1) one, O, of small diameter, loose upon its axis, around which is wound the registering paper; (2) one, O', of large diameter, actuated by clockwork, and over which passes the paper, which is carried along either through

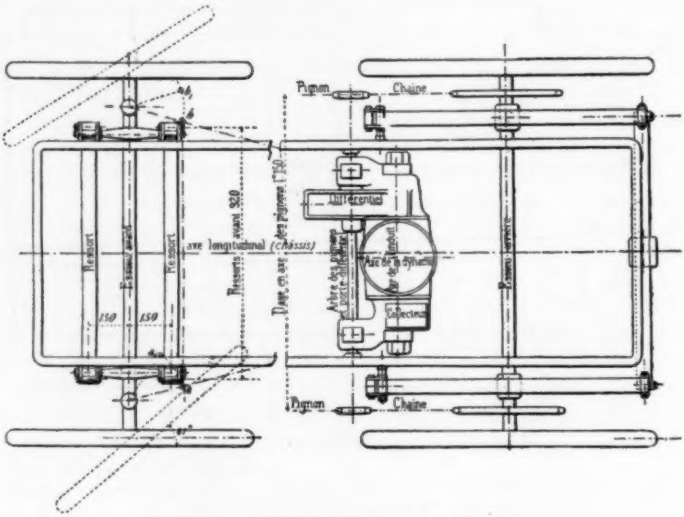


Fig. 30. Plan of the Landaulet Frame

simple adhesion to a rubber border, or through a series of small projections on the cylinder; and one, O'', of a diameter nearly equal to that of the first, actuated by a special clockwork movement, which unwinds the paper in measure as it is carried along by the large cylinder. The clockwork movement of the large cylinder is capable of taking on two velocities.

With registering dynamometers of the Morin type, we obtain only a record in gross of the various resistant forces, and that, too, only on condition that the vehicle and motor have the same velocity; since, otherwise, the dynamometric apparatus would register not only the tractive force necessary to overcome the

sum of the resistant forces, but also the relative acceleration resulting from the difference of the velocities.

A means of making the necessary correction is easily obtained by causing the apparatus to inscribe a dash upon the registering paper at every revolution of the wheel. If we suppose the unwinding motion to be sufficiently uniform, the spacing of these dashes will be in inverse ratio of the velocity. We shall therefore have a means of assuring ourselves whether or not the motion is uniform, or of calculating the acceleration concomitant with the stress registered. If there is any reason to suspect that the unwinding of the paper is not uniform, the vibrations of a tuning-fork may be inscribed, along with the dashes, at each revolution of the wheel.

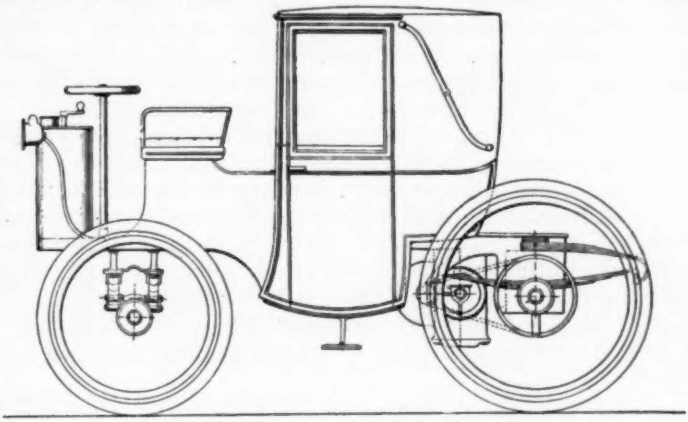


Fig. 29. Elevation of the Jeantaud Landaulet

Since in this apparatus the stress resulting from the slope of the ground intervenes, it is necessary to operate upon a road of which the leveling has been verified. Moreover, while the instrument is tared by static stresses, it is submitted during the experiment to dynamometric actions only.

With automobile vehicles, it is possible to interrupt the running of the motor and therefore abandon them to the various retarding actions to be measured. With a properly arranged track, very satisfactory results might be obtained by starting the carriage at the speed at which it was desired to obtain the pressure of the air and the sliding and rolling friction of the wheels and transmitting parts upon a portion of the track of sufficient length to obtain them without forcing the factor $\frac{P}{g} \frac{dV}{dt}$. The

speed obtained might be ascertained by causing the wheels, at a sufficient interval, to pass over two rubber tubes filled with air and of a diameter small enough to have no perceptible influence upon the motion. These two passages might be inscribed electrically upon a registering apparatus. At the entrance of the prepared track, the motor might be thrown out of gear and the vehicle be abandoned to the retarding actions enumerated above. Tubes like those already mentioned, placed here and there, would permit of registering the mean speed of the vehicle corresponding to each interval. The losses of live force, calculated with such data, would give the double of the resistant work.

The sliding friction in the hubs, the friction of the different transmitting parts, and the rolling friction upon the roadway could be progressively eliminated by successive experiments, and we should thus obtain the pressure of the air at different speeds, for a given carriage. Upon afterwards varying the diameter of the wheels, the suspension arrangements and the superficial state of the roadway, we should reach sufficiently exact results.

If, instead of having at our disposal a track thus arranged, and constituting a genuine laboratory, we were obliged to experiment upon some road or other, it might be possible to use the Morin dynamometer, even for an automobile, by interposing it between a traction vehicle and the carriage to be experimented with; but, fortunately, we have at our disposal a registering apparatus that permits us to dispense with a traction vehicle. We refer to M. Desdouit's dynamometric pendulum, which appears to us to be *the* dynamometric apparatus par excellence for automobile carriages.

This instrument is based upon the principle that a pendulum, capable of swinging freely in the plane of a carriage's motion, makes with the vertical, at every instant, an angle of which the tangent is equal to the acceleration of the speed at which the vehicle is running.

It consists essentially (Figs. 34 and 35) of a pendulum bob, $P P'$, formed of quite a heavy copper cylinder supported by two rods, $L L'$, attached at their upper extremity to a rectangular frame. Two other rods, $M M'$, parallel with the first, are fixed at their lower part to the same frame, at the same height as the centre of the bob.

These two systems of rods are connected by horizontal connecting-rods, $B B'$. For slight displacements, it may be admitted that the heads of the rods thus connected with the pendulum describe spaces that are augmented in a constant ratio with those described by the pendulum bob or with the tangents of the angles

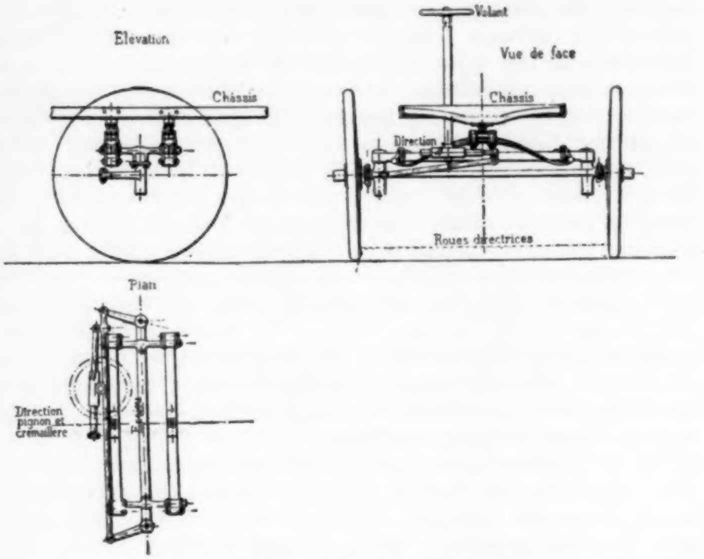


Fig. 31. Jeantaud System of Suspension

at the centre, which do not sensibly differ from arcs. These connecting-rods are jointed to two fly-wheels, *V*, which serve to reduce the too abrupt motions of the pendulum.

If, then, to the centre of a crosspiece, *T T'*, that connects the heads of the rods, we fix a pencil, *C*, the latter will inscribe lines proportional to the tangent of the angle α of the pendulum. upon a sheet of paper. It suffices to give the latter a proper transverse motion in order to preserve the measurement of the tangent of the angle made by the pendulum at every instant, that is to say, the measurement of the vehicle's acceleration.

The motion of the sheet of paper is effected through the arrangement that we described in speaking of the Morin dynamometer.

In order to utilize this property of the pendulum for the measurement of the various resistant forces that set themselves up in opposition to the movement of an automobile vehicle, it will suffice to throw the motor out of gear and take the angle of the pendulum upon the vehicle abandoned to its acquired speed. The angle of the pendulum will measure the retarding action.

But this latter is likewise a sum comprising the friction of the axle-journals, the rolling friction, the roughness of the road, the pressure of the air and the friction of the transmitting parts

between the disengaging gear and the driving-wheel. In an automobile carriage designed solely for the study of the resistances due to the state and nature of the road, we might have recourse to a transmission arrangement, such as an electro-magnetic device for throwing the sprocket that controls the toothed wheel of the driving-wheel into and out of engagement. However, with non-electric automobile carriages, if, after determining the coefficient of friction of the axle-journals through the Marcel Desprez method, analogous reckonings be made in leaving the gearings of the transmission in engagement, we shall have a sufficiently approximate measurement of the frictions of the transmitting parts. All that will remain, then, will be the retarding actions due to the air and road. The first will become nearly insignificant toward the end of the experiment, when the carriage has only a very low speed. At this moment, the angle of the pendulum will measure the retarding action due to the road alone, since the slope does not intervene.

If we operate in summer, upon a good macadam road, very free from dust, we shall be able to complete the experiment by having a definite quantity of dust sifted over the clean roadway after a certain number of days. It will be found that the angles of the pendulum continue to increase with the thickness of the dust.

After these experiments have been made, a definite quantity of water may be distributed over the road by means of a sprinkling cart, so as to convert the dust into mud. New readings of the angle of the pendulum will then give the retarding action of this changed state of the road.

A careful scraping will permit of making, upon a clean surface, some new experiments showing the influence of the mobility of the materials of the road caused by softening them progressively through the action of larger and larger quantities of water.

The experiments above suggested for trial upon metalled

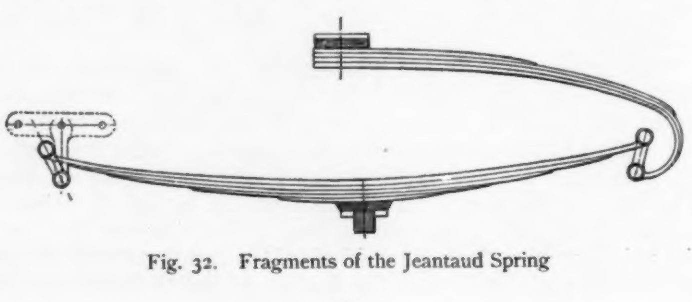


Fig. 32. Fragments of the Jeantaud Spring

roads may be repeated, with varying loads, upon asphalt, Belgian or wooden pavements.

The only difficulty connected with the use of the dynamometric pendulum resides in the maintaining of the zero of the graduation that corresponds to the position of the pendulum in the carriage without acceleration. Automobile carriages are generally provided with springs so soft and yielding that a change of position of the driver or experimenter suffices to cause the zero to vary; and in gasoline carriages, the same effect is produced even by the volume of the liquid that remains in the reservoir. So, what is obtained most accurately with this dynamometer is the difference of the stresses in passing from one road to another.

As regards the determination of the value of the pressure of the air at the different speeds of each carriage, the instruments herewith described leave much to be desired. On the contrary, should we have recourse to an electric carriage, it seems as if the experiment might be more easily tried with success. With the electric motor, in fact, nothing is easier than to note at every instant the quantity of energy consumed and, consequently, the power really developed, provided a table of the renderings of the motor has been previously prepared. It seems, moreover, as if such a table hight be easily established by placing the driving-wheels of the carriage upon rollers of which the resistant couple might be modified by a determinate tangential stress.

Therefore, upon running an electric carriage upon a given road, under the various experimental conditions enumerated above, we should easily determine the quantity of energy and, consequently, the power necessary to overcome the various resistances of the transmission, axle-journals, road, air, etc.

By running slowly at the outset, this latter resistance would be eliminated. Upon afterwards proceeding with increasing speeds, we should determine by subtraction the supplementary resistance due to the air at these different speeds.

It is evidently necessary that the experimenter shall be able to assure himself that the consumptions of energy ascertained are not rendered inaccurate by positive or negative accelerations of the vehicle.

Experiments with the electric carriage can therefore not be undertaken with advantage until we have a sufficiently accurate speed-registering apparatus at our disposal. As regards this, we shall confine ourselves to remarking that an apparatus of this nature consists of two distinct parts: an indicator of the number of revolutions of the wheel, and a device for converting such

number into speed. The odometer is a pretty delicate instrument to place upon a horse-drawn carriage, since it must connect the hub of the wheel with an apparatus fixed to the body, despite the variations in distance caused by the flexibility of the springs.

The majority of the systems adopted for such an application are based upon the compression, through a cam, at every revolution of the wheel, of a volume of air enclosed in a reservoir, which, through a flexible tube, communicates with another reservoir closed by a vibrating disk in contact with an indicating needle.

This method of communication, theoretically perfect, presents in practice numerous defects that result for the most part from the difficulty of keeping the joints tight for any length of time.

In the automobile carriage, such difficulties disappear, since the number of revolutions of the driving-wheels depends upon that of the transmission shafts—the differential shaft, for example. Since the latter is connected with the frame in an invariable manner, nothing is simpler than to transmit its rotary motion to a receiver placed upon the carriage body, and thence to a revolution counter.

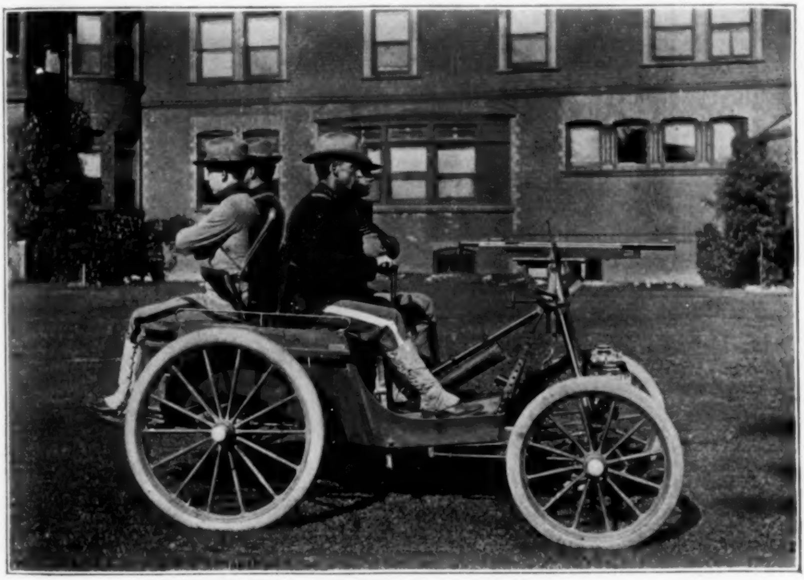
The apparatus for converting the number of revolutions into speed is as delicate in automobiles as it is in horse-drawn carriages. Nevertheless, there exist two or three types that are pretty accurate and, at the same time, quite simple.

It would evidently be possible to avoid the necessity of employing an odometer by using a dynamometric pendulum, which would immediately give the positive or negative acceleration corresponding to the consumption of energy ascertained.

Translated for the Automobile Magazine from *Le Génie Civil.*

Automobile for Light Artillery

FOR some time past Major R. P. Davidson, of the Illinois National Guard, has been making experiments with the automobile for the transportation of field artillery. He has invented a carriage large enough to hold four persons and to transport a rapid-fire gun. The entire weight of the carriage, with gun and equipment, is 1,600 pounds. The motive power is furnished by a 6 horse-power gasoline motor, with a reservoir



An American Military Automobile

containing sufficient fuel to operate the vehicle a distance of 100 miles. This motor has a speed of 30 miles an hour on a smoothly paved thoroughfare, while on the average country road a speed of from 10 to 15 miles an hour can be maintained where the grade is medium. The gun carriage is equipped with a special apparatus for hauling by hand up steep ascents, thus aiding the motor and for assisting the power on roads where the sand and mud are unusually deep. It is found that the gun crew of four men can

prevent the vehicle from being stalled by use of this apparatus, except where the roads are simply impassable on account of mud and sand.

The gun with which the automobile is equipped is of the Colt pattern, firing 480 shots per minute, of a calibre of 7mm. It has an effective fire range of 2,000 yards and uses smokeless powder. The bullets have a muzzle velocity of 2,000 feet. The gun can be loaded and fired by one man, who is protected by detachable bullet-proof steel shield. The gun squad is equipped with Colt army and navy revolvers of 38 calibre.

The tests made by Major Davidson have been extremely severe, and thus far the carriage and gun have given satisfaction. It has been utilized in cross-country marches with a squad of bicycle infantry, traveling over ground covered with large stones, pieces of wood and limbs of trees. It has also been manœuvred in stubble fields, where the ground was extremely soft, and has accompanied the cyclists on marches along roads where the mud was several inches deep in rainy weather. Military experts who have examined it are of the opinion that the carriage is extremely suitable for light artillery, and in some instances it is much better than the use of animal power.

The automobile gun and its crew, in command of Major Davidson, recently made what might be termed a forced march from Chicago to Washington over the ordinary highways. The commander brought a message from Gen. Wheeler to Gen. Miles.

A DEVOTEE

Fair Phyllis, once the humble slave of tennis,
Went forth to freedom in the throes of golf.
The shackles worn in courts of chalk and netting
Were straightway loosed and taken off.
And then a season's whirl of tees and cleeks and drivers—
A season's joy that lingers with her yet—
And glad, she views the shackles reappearing
Heart-forged within a little voiturette.

Frank X. Reilly, Jr.

The Automobile as a Pastime

By Miss N. G. Bacon

TO dabble in motoring as a pastime is an expensive luxury, and the devotee should furnish himself with a long and heavy purse, with very loose strings. The enthusiastic automobilist takes a keen and intelligent pride in all that pertains to his car. On all occasions, in season and out, he affectionately refers to the parts that form the internal anatomy of his hobby horse, which he "runs to death" in more ways than one, so far as can be gathered from the adverse criticisms of his compeers. The balance of time, talent, and money spent in adjusting, studying, or improving the mechanism greatly exceeds that given to the pleasures of driving. Clad in oil-stained overalls, hands soiled and greasy, the devoted motorist may daily be seen paying personal attention to the vital parts of the mechanism. On rare occasions, indeed, he may be discovered hidden in the depths of a pit, or lying on his back under the car, carefully and attentively paying his best respects to some otherwise un-get-at-able piece of workmanship. This labor of love is varied by attendance at the club-rooms for incessant repetitions of "tall tales," thrilling episodes and narratives of events worthy the genius of a Mark Twain or a fisherman. Luxuriously sheltered and comfortably seated in an upholstered sofa-lap, the captivated motorist spins out his experiences, or invents them, compares notes with his confrères, and acquires a renewed interest in the idol of the hour.

All this may be pure amateurism, but it represents the initiatory stages which all pioneers have to traverse ere they can evolve from the chrysalis into the full-fledged motorist. Experts who have safely maneuvered their destinies beyond amateur enthusiasm, speak eloquently concerning motoring, both as a sport and as a commercially successful means of road locomotion, whilst those who are of a "sportive" trend of mind claim for it an exhilaration and a fascination unexcelled by hunting or yachting. M. René de Knyff, the famous winner of French automobile races, goes so far as to declare that automobilism possesses a similar fascination to horse racing, except that the driver has to perform the double function of jockey and trainer. The automobilist is the trainer before the race has commenced, but when once started, his judgment comes into play to control and force speed, and to avoid "spills." The uninitiated imagine that the

automobile can be set going by the manipulation of certain levers, and that nothing further is required of the driver; but those versed in the ways of motors realize how much the speed and easy running powers of the vehicle depend upon the skillful handling and knowledge of the mixtures, the engine, and the mechanism generally. Any lack of adjustment, loss of rhythm in the movement of the engine, or failure of electric current means bad running and low speed. It remains for the genius of the motorist, who with skillful and delicate touch and hearing discovers the causes that prevent, or that seem to secure, the harmonious working of the machinery, and herein comes much of the fascination and charm of the pastime. When for some unknown reason the engine loses its " tone," the car shirks its work, and threatens at any moment to stop, the motorist is overcome by a very thoughtful and even pensive mood; his meditations are deep and penetrating, various trials of mixtures and complex adjustments are tested. If luck comes to the rescue, or knowledge triumphs, a happy hit is made, and the motor suddenly gathers itself up, springs to its work and recommences to pace its way merrily. Such exquisite experiences are rare, and for that reason give pure joy. Even the most fastidious critic would be tempted to become a rash enthusiast were the conditions invariably favorable to a successful trial trip, for the marvelous ease with which automobiles do sometimes run excites wonder, and provides enjoyment of the highest nature.

In comparing motoring with cycling a Frenchman denounces it to be inferior. To use his own phrase, he considers that " the memory of landscapes persists in the tourist's mind in inverse ratio to the rapidity of the means of locomotion which he employs to traverse it." I presume Ruskin himself would recognize this to be a truism. In the critic's opinion railway traveling only affords a brutal kaleidoscope, rolled so rapidly before the eyes that the attention can be fixed upon nothing, and the mind conveys but a fugitive impression of towns, historic neighborhoods, ravines ,suspension bridges, and landscape scenery passed. This may be, but surely it is false to state that the experienced driver lacks *opportunity* to enjoy the passing view, unless, indeed, his automobilism is reduced to a craze for racing at a break-neck pace to appease his ambition to cover as much ground in as little time as possible. But even in such a case there is exhilaration and exaltation in rushing through the air at such speeds unprotected by wind-guards or what-not. The control and steering of a car becomes purely automatic, and nothing is easier to those who delight in the beauties of Nature's handiwork than to slow down

the engine and view the scenery at any pace that suits the motorist's fancy when passing through ideal spots of natural beauty. Indeed, the thrill of motoring comes in when the motorist, by bringing into action his automatic brain, allows his mind to be concentrated upon the fascination and exhilaration of the pastime. Forgetful even of speed, and oblivious to all else except the pleasures of the sport he is at that moment enjoying, the automobilist is carried away into realms of fancy. The wings of his thought taking flight, he is so enraptured with the intensity of his feelings that he revels in a hitherto unknown joy. Whirling at a high rate of speed with little or no exertion affords a pleasure of the most exalted nature, especially in favorable conditions. During the winter months motoring is cold work, although exhilaration remains, but in the tropical heat nothing can be more pleasant. It is imperative, if comfort is to be assured, that plenty of fur and warm clothes are worn to keep out the cold and biting winds of indifferent weather.

The ways of motorists, indeed, are as variable as they are interesting; but if the poet who compressed his philosophy into "Variety is the spice of life" is correct, the automobilist's existence is one of continual spiciness. The craze for speed and extensive mileage, the poetic charms conveyed to the mind by Nature's grand display of beautiful scenery, the pure pleasure of threading shady lanes surrounded by natural beauty, the study of the experimental workings of the machinery under command for trial and test purposes, and the eventual control of the innate cussedness of hitherto incomprehensible motor maladies, all provide an everchanging range of recreative delights. Automobilism presents to the devoted aspirant an ambitious climb up the rugged ways towards heights hitherto unreached. At every point of the ascension there abound unpublished records awaiting the perseverance of the skilled automobilist to proclaim to an ignorant world. Speed there may be, but how can it be maintained and so controlled as to be, as it were, "on tap" when wanted? General efficiency comes next, and here again much experimental and practical work awaits the skill of the expert. There never was such a happy hunting ground for those with skill, knowledge and ability as there to-day exists in the arena of automobilism, and no better work could be done for the community at large than the solution of many of the intricate mechanical problems that beset the path of the pleasure-bent motorist.

Automobiles there are in abundance, in various stages of development and progress towards perfection. Maybe the novice feels most strongly drawn to the motor cycles, seeing that they

afford the easiest method of study. The driving mechanism is in evidence, and more get-at-able than in the larger cars. The motor-bicycle, only recently so perfected as to possess something more than a modicum of reliability, may eventually prove itself to be the most popular vehicle for experimental purposes, in consequence of its easy steering and storage, and its comparatively light weight and inexpensiveness. The tricycle and quadricycle take their stand as immediate successors. For winter riding the motor cycles, seeing that they offer facilities for additional assistance by pedal work, might by some be recognized as the most enjoyable, for in such machines the motorist can at will exercise his own motor muscles, and increase his personal warmth as well as the speed of his vehicle. Peculiarly enough, however, the motor cyclist *per se* dislikes to use his pedals, and is ever on the lookout for a machine which, although started and put into motion by the pedals, requires no further aid from them or his muscular development.

It should not be forgotten that motoring as a pastime is still in its infancy, and while a few pioneers are interesting themselves in its pleasures, the general public at large remain in lethargic ignorance and dubiousness of its incontestable delights. Yet one of the officers of perhaps the largest manufacturers in England has given it as his experience that even the most dubious are invariably converted so soon as they have completed their first ride on an automobile.

Gasoline Automobiles for Light Delivery Service

THERE are a great many small stores, laundries and other small business establishments, not only in the larger cities, but also in towns of moderate size and in suburban districts, the requirements of which for delivery service do not call for as great carrying capacity, either in bulk or weight, as is furnished by the electric delivery wagon. To meet the demand from this quarter, and also to assist in handling the delivery service of large establishments, such as department stores and others, for the major part of which electric wagons, or, what it may be safe to assume they will soon be called, the old-fashioned horse-drawn wagons are regularly employed, a little gasoline automobile was put out by the Pope Manufacturing Company nearly two years ago. In spite of the novelty of the gasoline vehicle in this work, and notwithstanding the unfortunate ignorance which still exists in many quarters as to the possibilities and limitations of all automobile vehicles, this small machine has slowly and surely been working out a good reputation for itself. It is believed that, incidentally, it has done some educational service in the gasoline automobile field. In any case, there is evidence that it has developed in several of the individuals owning these machines a desire to own as well a passenger vehicle of similar economy and convenience in operation. This gasoline motor delivery vehicle is a tricycle, the front wheel being used for steering and the two rear wheels for drivers. It is now being manufactured for the Electric Vehicle Company of New York by the Columbia and Electric Vehicle Company of Hartford. As an example of the trend which gasoline mechanical constructions are taking by force of American conditions, which are certainly in many cases widely different from the conditions prevailing in France, where gasoline automobiles are growing daily in popular favor, not slowly, but by leaps and bounds, some of the features of this tricycle are of interest.

It is driven by an Otto cycle engine, with cylinder measuring $3\frac{1}{2}$ inches by $3\frac{1}{2}$ inches. The engine is started by ordinary bicycle pedals operated from the rear saddle on which the driver sits, the pedals being also, however, available for use to assist in the propulsion of the machine when required for this purpose by an abnormally steep grade or the necessity of an unusual output of

power for any cause. As first placed on the market, the engine was entirely air-cooled, and lubrication was automatic from a single charge of oil, which was supposed to be placed in the crank case of the engine once a day.

After a year's experience it was found that much of the service to which the machine naturally gravitated was what might be called the "peak" of the load for large department stores, and service sometimes calling for hurried deliveries of packages in comparatively small numbers, besides the other classes of work for which it was planned. As a rule, no extremely heavy load being carried for any of this service, it became possible to run the machine at its highest speed, and hence, at the end of a year, the severity of the service on the engine was found to exceed what it would have been if greater loads had been carried.

As a result of this experience it was found that this size of engine running continuously with a cylinder and explosion chamber merely air-cooled would become overheated. Hence a water-cooled cylinder head was adopted, and proved to entirely do away with this difficulty, decreasing the cost of maintenance and increasing the capacity of the tricycle. It was also found that many of the drivers employed on these machines by their owners, were boys, and could not be relied upon to invariably give the matter of lubrication the attention it deserved A charge of oil was put into the crank case whenever the driver happened to think of it, and frequently he did not think of it for several days. One of the objects in building it has been to render it as simple as possible, even at the sacrifice of refinements in the line of automatic features. Therefore, in order to overcome the difficulty resulting from lack of attention to the necessity of daily oiling, it was considered advisable to mount a sight feed oil cup directly on the handlebars of each machine, and run from it a little tube to the engine gear case, so that whenever the driver mounted the machine the oil cup could not fail to be conspicuous, and suggest to him that oil was needed, in case it happened to be empty. Further, a sure and gradual feed of the oil was found to render very slight indeed the maintenance expense in cylinder packing rings, and the wearing parts within the cylinder, and the crank case.

Of course, for winter use in cold climates the oil has a tendency to thicken in the tube between the oil cup and the crank case, but, wherever required, this is easily overcome by mounting the oil cup over the top of the engine, where the heat is bound to keep the oil thin enough to feed properly The cup is still conspicuous enough there to remind the operator that if a horseless carriage does not need oats, it still needs oil.

Gasoline Automobiles for Light Delivery

While on the subject of oil, it may be of interest to many prospective users of gasoline automobiles to be informed of the desirability of obtaining for use in the cylinders of small gasoline engines, an oil which will both furnish good lubrication at high temperatures and at the same time not incrust in the cylinder. If oil not carefully selected is used here it will cake up in thin layers in the cylinder and over the piston, and these incrustations are liable to become red hot, thus causing premature ignition. The Columbia people claim that, after many careful tests of lubricating oil, they have succeeded in finding an oil which is entirely satisfactory for service here.

For ignition, both the means involving the use of a red hot platinum tube and of an electric current supplied by a battery and otherwise, were tried. It was found that while the hot tube method had several obvious advantages, the wick in the hot tube burner would gradually become charred and affect the flame to such an extent that the tube could not be maintained at a high enough temperature to give the right point of ignition. Of course, this resulted in lack of power and speed, and inability to cover distances in a reasonably short time. It also rendered the machine less attractive from the point of view of owners who desire to place it in the hands of drivers without any especial mechanical experience or insight. This objection, together with the advantage that would come from the possibility of making an instantaneous start, led to the adoption by the makers of electric ignition. The greatest difficulty here was the source of current. The magnetic igniter, in the hands of drivers of such vehicles, and especially on vehicles unprotected from the weather, as this machine is, would hardly be practical. Primary batteries of all descriptions were tried, but without success, and finally a two-cell storage battery of an ampere hour capacity of fifteen, was found to be the best and most satisfactory. A secondary or jump spark is used with a non-vibrating coil. This ignition gives excellent results, and if explicit rules laid down that a new storage battery must be substituted every Monday morning are followed, and the exhausted ones recharged, it is almost impossible to damage it.

The method of control involves the varying of the point of ignition. The lever by which this is done has a spring return to the position, which insures the engine running slowly. It is placed to be operated by the knee of the driver when he mounts the machine. The ignition is early enough to start with the lever held back as far as it will go, unless the mud is too deep or the grade too high. If necessary to advance it, either in order to start under adverse conditions or to speed up, the driver only

needs to push the lever forward with his knee. Of course, when he dismounts from the machine, the spring return lever instantly brings the ignition back to a point low enough to avoid racing the engine. This has proved on long service to be a valuable means of adding to the durability of the motor and its wearing parts, and certainly adds to the claim made by the company that their gasoline tricycle is as simple and as proof against injury due to carelessness or inexperience as any gasoline automobile can be made. With the two speeds provided for the machine by the change gear, this method of varying the speed is adequate to furnish all the variations in the rate of movement which are called for. Experience has indicated that it is more economical and otherwise satisfactory than the throttle control, which was also tried. In the majority of instances the boys hired to drive the machines would entirely forget to open the throttle in starting or to close it when throwing out the clutch. Of course, in the first case, the machine simply did not start, and, in the second case, the engine was allowed to run without carrying any load at an injurious rate of speed. With the method of ignition control described the throttle is left wide open, and, while in theory the use of gasoline is not in this way kept at a minimum, in practice it has been shown that by keeping the speed of the engine at the lowest point, the cost of gasoline per mile is in reality less than with a throttle. The carburation is by a surface carbureter of the standard type.

It is not necessary to say that the maintenance expense per annum of such a vehicle needs to be made low in order to suit the management of a dry goods department store. If the user of one of these machines will provide himself with gasoline of the proper test degree, which, by the way, is exactly the same quality of gasoline as is regularly used in gasoline launches of the leading manufacturers; if he will have the machine overlooked by the foreman in his delivery department, or some other fairly responsible person with a little mechanical insight, and if he will employ a boy of average intelligence to run it, the Columbia Company claims that it has been demonstrated that this little business vehicle will prove practical and reliable.

One of the large department stores in a Pennsylvania city made, in the course of its regular service with one of these tricycles during the week ending February 10, the following records for three different trips:

First trip, 32 packages delivered in 65 minutes; distance, about 4 miles.

Second trip, 31 packages delivered in 70 minutes; distance, about 4½ miles.

Third trip, 33 packages delivered in 90 minutes; distance, about 6 miles.

Another of these tricycles, during the week preceding Christmas, was run steadily each working day, and delivered each day a number of packages varying from seventy-four, the minimum for one day, to one hundred and ten, the maximum for one day. These figures, however, fail to convey an accurate idea of its possibilities, as it is almost invariably used for long-distance service, and for reaching points to which it would not pay to send a horse-drawn wagon or an electric wagon without a full load.

The tricycle feature of the vehicle makes it possible to guide it accurately where very little space is available for movement and turning. It can thread its way through an ordinary traffic in localities where it is intended for use. Its total weight is 900 pounds, and it carries enough gasoline on a full charge of the tank to provide for running 100 hundred miles and enough water for 25 miles. It has a maximum carrying capacity of 500 pounds, and with this load can easily be made to average in city service over 11 miles per hour The appearance of the machine is shown by the accompanying cut.

Legal Opinion on Automobiles

Interesting Decision Handed Down by Judge Sutherland

PROGRESSIVE VERSUS PRIMITIVE MEANS OF LOCOMOTION

A DECISION which is of considerable interest, in that it concerns the legal status of the use of automobiles or other horseless carriages in the public streets, was handed down by Judge Sutherland, in Rochester, N. Y., recently, in the case of Fred. Mason and another against Jonathan B. West.

In the opinion, which is published in full below, Judge Sutherland rules that the vehicles in question have a right on the streets, and that the owner or operator is not responsible for damages which may result from fright caused to horses, unless there is contributory negligence.

The decision is on an appeal taken by Mr. West from a judgment of the municipal court for $42.95 damages and $10.95 costs. Mr. West is the inventor and owner of a steam vehicle of the horseless variety, and while operating it on Tracy Park, October 18, 1898, a horse belonging to Mason became frightened at the vehicle and ran away, resulting in injury to the horse and damaging the wagon. Reed & Shutt were attorneys for the plaintiffs, and Hon. John B. M. Stevens, the present special county judge, appeared for Mr. West. The decision of Judge Sutherland follows:

Plaintiff's horse and delivery wagon were standing on Tracy Park, Rochester, October 18, 1899, the horse being hitched by a strap attached to a thirty-pound weight. The roadway on Tracy Park is fifteen feet from curb to curb. Defendant entered Tracy Park at Alexander street with his motor carriage, and as he approached plaintiff's horse, who was headed towards Alexander street, became frightened at defendant's outfit and ran away, damaging the wagon and harness to the amount of $17.45. The horse received no injury except such as come from fright. The municipal court, in addition to the $17.45, allowed $25 damages for deterioration in value of the horse, supposed to follow from the increased propensity of fright induced by its experience on this occasion.

In Hitchell *vs.* Rochester Railway Company, 151 N. Y., 107, it was held that mere fright caused by negligence does not give to the person frightened any cause of action, no matter how serious the fright may be in its after effects. It is argued with

much force that for the same reasons of public policy which were controlling in the Hitchell case, the item of $25 damage to this horse for fright should have been disallowed. Furthermore, this horse, it seems, had run away twice before, and it would require a very nice insight to determine, without speculation or mere guesswork, what effect this scare had upon its permanent psychic equipment.

But passing that, a more important question is presented, whether any recovery should be had. This motor carriage was made by defendant, and as described by the witnesses and shown in the photograph exhibits, while somewhat crude, it does not differ very materially in general appearance from the steam automobiles which are coming into common use. It runs on four wheels with pneumatic tires; has a canopy top and is about the size of a one-horse delivery wagon. The motive power is steam generated by a gasoline burner. A smokestack connecting with the combustion chamber extends to the top of the canopy in the rear. There are sinuations in the stack through which the escaping vapor and the exhaust steam passes, and the design is that the exhaust steam shall be condensed inside the stack. This stack would seem to be the main point of dissimilarity in appearance between defendant's machine and other motor carriages operated by steam.

The horse has no paramount or exclusive right to the road, and the mere fact that a horse takes fright at some vehicle run by new and improved methods, and smashes things, does not give the injured party a cause of action. As Judge Cooley says in Macomber *vs.* Nichols, 12 Mich., 212: "When the highway is not restricted in its dedication to some particular mode of use, it is open to all suitable methods, and it cannot be assumed that these will be the same from age to age, or that the new means of making the way useful must be excluded merely because their introduction may tend to the inconvenience or even to the injury of those who continue to use the road after the same manner as formerly." If the defendant's motor carriage is practicable for the purpose of travel and the noise and vapor caused by its use are kept within reasonable limitations and are no greater than are fairly incident to the use of motor carriages which are found adapted to the needs of the general public, then I cannot see how the defendant can be held liable in the absence of evidence that at the particular time complained of the carriage was operated carelessly.

If one should find it desirable to go back to primitive methods and trek along a city street with a four-ox team and wagon of

the prairie schooner variety, it would possibly cause some uneasiness in horses unused to such sights. Yet it could not be actionable, in my opinion, if a runaway should result, provided due care were shown not unnecessarily to interfere with the use of the highway. Horses may take fright at conveyances that have become obsolete as well as at those which are novel; but this is one of the dangers incident to the driving of horses, and the fact cannot be interposed as a barrier to retrogression or progress in the method of locomotion. Bicycles used to frighten horses, but no right of action accrued (Holland *vs.* Bartch, 120 Ind., 46; Thompson *vs.* Dodge, 58 Minn., 555). Electric street cars have caused many runaways. Automobiles operated without steam, by storage batteries or by gasoline explosion engines, running at a moderate speed, may cause fright to horses unused to them; yet the horse must get used to them or the driver take his chances.

The evidence in this case shows that defendant was running his motor at a moderate rate of speed and as it approached the horse he slowed up. Defendant and his wife, who was with him, say they came to a full stop before the horse started to run, but this is contradicted by plaintiff's witnesses, who admit he slackened speed.

It will not do to say that it is proper to run any kind of a contrivance upon the street in which persons may be carried. A machine that would go puffing and snorting through the streets, trailing clouds of steam and smoke, might be a nuisance, but this is not such a case. It cannot be said that the defendant's machine is such a departure in its construction or mode of operation from other steam motor carriages which experience has lately shown to be entirely practicable for street use, as to make it a nuisance, although, because of the present novelty of horseless carriages, horses may take fright at its approach. There was no proof of an unusual amount of vapor escaping at the time of the accident, nor of any amount of noise greater than is ordinarily heard in running a machine of that character, and to sustain this judgment is to condemn the defendant's motor carriage and all others operating in a similar way, and to declare them impracticable and unfit for use upon the streets.

There is a statute against the use of any vehicle propelled by steam in public streets (except on railroad tracks), unless a person is sent at least one-eighth of a mile in advance to warn travelers of its approach (Highway Law, sec. 155; Penal Code, sec. 640, sub. 11). This statute, though broad enough to cover the motor in question, was passed before automobiles were in use, and it was directed against traction engines, which are ponderous

and noisy affairs, and have been the cause of much litigation (Mullen *vs.* Glens Falls, 11 App. Div., 275). The provision of law that the forerunner must precede the steam carriage by at least an eighth of a mile, shows that it was not drawn with steam automobiles in mind of the kind used in this case; and if a man had been sent that distance ahead, it would have been of no value to plaintiffs as a warning, for their driver would not have met him, so it cannot be said the accident occurred because of defendant's failure to comply with the law referred to.

The temporary inconvenience and dangers incident to the introduction of these modern and practical modes of travel upon the highway must be subordinate to the larger and permanent benefits to the general public resulting from the adoption of the improvements which science and inventive skill have perfected.

The judgment appealed from is reversed.

A TRIP DOWN LONG ISLAND ON A MOTORETTE

Mr. Field, Vice-President and General Manager of the De Dion–Bouton Motor Company, of Brooklyn, accompanied by Mr. Andrew Binker and Mr. F. H. Ball, took a trip down Long Island recently on one of Mr. Field's motorettes and made a very successful run and creditable record. A considerable portion of the roads was found to be very dusty, owing to the fact that there had been practically no rain for two months. The average time of the vehicle was over 15 miles per hour and was maintained throughout the trip, except for about 10 miles in crossing the Island from East Cove to River Head, where, owing to the deep sand, it being eight and ten inches deep, much slower time was taken for these 8 miles. The route followed was down the Merrick road on the south side as far as East Cove, a distance of about 85 miles, and from there across to the north side to River Head, and from there along the north shore to Greenport. The total distance of the route traveled was about 120 miles which certainly seems a good record for one of these little motorettes with three persons on board, as well as a large amount of baggage and gas sufficient for the entire trip.

The Value of Alcohol in Automobile Practice

IT is extremely interesting to follow the course of the experiments with alcohol as a source of motive-power in automobile work, conducted in France and Germany, notwithstanding the fact that by reason of our foolish taxation of alcohol used in the arts, the matter at present has no immediate practical value for us in this country. In Germany alcohol so used is not taxed, greatly to the industrial advantage of that country. Great manufacturing interests have, in consequence, been built up there, and now the possibility of utilizing alcohol for motive-power gives another enormous advantage to Germany. In France there is a tax upon alcohol used in the arts, although slight in comparison with that imposed in this country. But now that alcohol has been shown to be of great value in automobile work there is in France a strong movement to have the tax removed. This movement naturally finds hearty support among agricultural interests, for it would mean increased demand for important staples.

Recent very thorough tests in France appear to show that alcohol can easily be used in ordinary gasoline motors, with little or no change in the mechanism. And the following advantages of alcohol over gasoline are said to be undeniably shown: Freedom from odor; greatly diminished vibration and consequently a notable economy in wear and tear of machinery; less violent explosions; greater power in up-hill work; reduced danger from fire; better regulation, and the utilization of an important national product. The only inconvenience is said to be the necessity of carrying a somewhat greater fuel supply for the same amount of work; an increase of one-quarter to one-third as much in quantity. The explosions being less violent, the operation of the motor is more like that of a steam engine. In consequence there is much less vibration. The better regulation is due to the fact that the volume of alcohol admitted into the explosion cylinder is considerably larger than in the case of gasoline, and in consequence a more exact charge or dose, is possible; moreover, a slight excess in the amount of gasoline admitted into the cylinder causes a complete derangement of the motor, a result which would only follow from the admission of a great excess of alcohol. The reduced danger from fire proceeds not only from the

fact that alcohol is less volatile than gasoline, and therefore much less liable to produce explosions either when transported or in storage, but also because from the nature of alcohol the application of water at once puts an end to combustion when it catches fire, water mixing with it and diluting it to below the burning point. On the other hand, gasoline being of an oily nature, the application of water only tends to aggravate the trouble by spreading the inflammable area.

It has been shown that alcohol can be produced in this country at a price per gallon less than that of gasoline. The latter, with other volatile products of petroleum represents only a very small percentage of the crude petroleum. Consequently the price must advance with the increased demand. Were alcohol, however, relieved from taxation when used in the arts the demand would lead to a greatly increased production and a tendency toward diminishing cost. The industrial possibilities are so great, and the economic advantages so manifest—resulting in an addition to our sources of wealth that would represent new products to the amount of millions and millions in annual value—that it would seem as if the relief from taxation must come in the near future. Indeed, that end was well nigh accomplished a few years ago, Congress having enacted a law to that effect, but unfortunately permitting its execution to rest with the discretion of the Secretary of the Treasury. Unfortunately the gentleman who occupied the position at that time was not inclined to assume new responsibilities, and the inertia of his subordinates led them to represent that it was inconvenient and inexpedient to carry the law into practice. In consequence the law was never carried into effect, and the country has consequently suffered a great loss in industrial possibilities.

The "laziness plea," however, ought in the nature of things not to be allowed long to bar the way to the achievement of the desired end. If it should, it would be a strange comment upon our national reputation for commercial energy and manufacturing enterprise, and we would suffer sadly by comparison with the astute and level-headed Germans. The great interests that would be benefited by such a step ought to unite in a vigorous effort to bring it to pass. Among these are the agricultural, which would profit by a greater market for their products, particularly in the way of grain, beet-roots, potatoes, etc.; the distilling interests, whose business would be vastly increased; and wide-spread manufacturing interests, which would be benefited in various ways. And the entire country would gain by the prosperity resulting from an increased volume of trade and the addition of valuable new products to our agricultural and industrial output.

Even now, however, our automobile manufacturers should be able to profit by the developments in relation to the use of alcohol by making vehicles especially designed to that end for export to countries where alcohol may be profitably employed for motive-power purposes. Among these countries both Cuba and Mexico should present very favorable fields, as well as Porto Rico and other West India islands—unless Porto Rico may be temporarily spoiled for the purpose by the extension of our internal revenue laws to the island. In all of these countries alcohol is produced very cheaply from the sugar-cane.

Mexico presents probably one of the best fields for exploitation in the near future along these lines, for the reason that the Mexican Electric Vehicle Company, one of the sub-companies of the great American Electric Vehicle Company, has laid the foundations for the building-up of a very extensive business there, with important concessions for cab-service and omnibus lines in what is becoming one of the magnificent capitals in the world. The company's range of motive-power is wider than its name implies, and it may use anything for the purpose it sees fit, beside electricity. And the field for alcohol seems to be exceptionally favorable, for the reason that at present motive-power is very costly there, owing to the high cost of coal, wood and other forms of fuel. All petroleum products are very expensive in Mexico, by reason of duties and freight charges, and this makes gasoline extremely high. On the other hand, alcohol is very low in price, so that its use in automobile practice would naturally be vastly cheaper than gasoline. The explosion type of motor, consuming alcohol instead of gasoline, hence seems to be peculiarly adapted to Mexican conditions. It would therefore be well for the Mexican Electric Vehicle Company—which is reputed to have an alert and progressive management—to take due advantage of the circumstance.

The object lessons furnished by the successful application of alcohol to automobile practice in countries so close at hand should have a powerful influence in inducing the relief of alcohol used in the arts from taxation in the United States.

It may be mentioned that the best results appear to be obtained from the admixture with the alcohol of a certain proportion of some product of petroleum. This likewise acts as a very effective " degrading " agent, for it not only prevents the use of such spirit as an intoxicant, but makes hardly possible its redistillation by fraudulent means for " moonshining " ends in the evasion of the revenue laws.

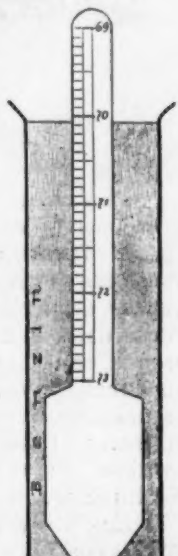
The high price of alcohol makes experimentation in its use a rather costly procedure for inventors or manufacturers. But

since alcohol used in the arts for scientific purposes in schools and colleges is exempt from taxation, such experiments might well be conducted in connection with the mechanical departments of some of our technical schools, like the Massachusetts Institute of Technology, the Worcester and the Troy Polytechnic Institutes, or the Columbia College School of Mines and the Lawrence and Sheffield Scientific Schools at Harvard and Yale, respectively.

SYLVESTER BAXTER.

A Gasoline Meter

DRIVERS of gasoline carriages are perhaps not so well acquainted as they should be with the small instrument which we figure herewith and which is designed to test the quality of the hydrocarbon that they use in their motors.



The apparatus, which is a form of the hydrometer, and is called a "benzine meter" or "gasoline meter," consists of a closed graduated glass tube filled with air and terminating beneath in two bulbs, the lowermost and smaller of which is filled with a definite quantity of mercury.

The weight of the instrument is so calculated that when it is placed in the hydrocarbon the graduated tube rises or descends therein according to the liquid's density, which may be read upon the scale of degrees. Benzine of a density of 0.69 is of good quality, that of from 0.70 to 0.71 is middling, and such as is below 0.71 ought not to be employed.

Only a small quantity of liquid is required for making the test, and this should be placed in some narrow vessel like a test-tube, which, of course, should be so much the deeper in proportion as the instrument is longer.

The De Dion Voiturette

SEVERAL times during these dull wintry months it has been my pleasant lot to receive visits from various English friends connected with the automobile industry who were desirous of giving the De Dion-Bouton voiturette practical trials under the worst conditions of weather, up stiff hills and down deep dales in slush, loose gravel, some even stipulating that it should rain, and the weather and roads have been so continually bad that I have seldom had difficulty in obliging them. The same sentiments were always confided to me, " If she will go through this wind, rain, and over these sodden roads to Versailles and back without a mishap, then she will do everything and go anywhere in England."

English weather, hills, and roads were pictured to me in the worst possible light, until I began to think that I did not know the climate or country, and that no small carriages, without being specially constructed and fitted with very powerful motors, would make anything like headway, or be a commercial success in England, so that I was most anxious on each occasion to put the voiturette through the worst possible trial, though after the first ride with English friends aboard it was a matter of interest alone, as I had no doubt what their verdict would be.

I will describe one trip which may be taken as a fair sample of many. For reasons explained above the drives were taken under conditions of road and weather that would not usually be selected for recreational automobilism. From my particular suburb of Paris, near the De Dion-Bouton Works, perhaps the route to Versailles is one of the most difficult for a small car to accomplish, and one cold December morning found us leaving the works on the Quai de Seine, accompanied by two *gros bonnets* of the English autocar world.

Rain was falling fast as we steered towards Suresnes, over the horrible *pavé* through Puteaux, but, as we were provided with leather jackets and caps I had borrowed from sundry employees at the works, we were quite prepared to encounter any weather.

We were four robust companions *de route,* and each could comfortably turn the scale at twelve stone, excepting myself, as I weigh fifteen stone, so that our springs were well flexed.

As we drove along our pneumatic tires sank a good inch and a half into the loose, muddy gravel, comprising the road surface, so that the three horse-power motor had all its work cut out, and was put to the severest test, especially as we commenced to ascend the long two-miles hill of Suresnes, but the engine never faltered a piston stroke all the way, and we climbed at about six miles per hour with perfect ease. The rain had cleared up somewhat, and from the Suresnes Hill a magnificent view of Paris is to be enjoyed on a fair day. We could distinctly discern, in the distance, the Tower Eiffel, surrounded by the Exposition Buildings, and this bird's-eye view made one of my friends exclaim, " What a gigantic exhibition it will be." The whole plan of the exhibition could easily be followed from Suresnes just before we turned off sharply to the right, under the railway bridge, up a very stiff piece of hill about six hundred yards long, known as the "*Cote de la Tuilerie,*" which is about one in eight to one in nine all the way, before joining the road that leads up to the Fort Mont Valérien.

We got up this part of the hill so well that I noticed my friends were exchanging views with a smile of contentment upon their faces.

I explained to them that during the various road races I had witnessed many of the big motor cars shed their belts, whilst others had broken their chains up this hill, at which they did not appear surprised; yet our little De Dion voiturette was only a three horse-power motor, with four passengers aboard, and it was successfully doing the same work as a six or eight horse-power car. One enormous advantage, I pointed out to my friends, was

the lightness of the De Dion voiturette, all the frame being made of weldless steel tubing, and in the carriage body the panels are of sheet aluminium. One thing they were astonished to learn was that no belts or chains were used to drive the carriage (or to shed or break). But I promised them I would explain the voiturette fully when we stopped at Versailles.

At the top of the hill in question, like all motor men of a practical mind, they made our driver stop, as they desired to see if the motor had got hot, so we pulled up and descended in order to feel the water jacket around the motor, and examine the radiator, and we found everything to our satisfaction.

My friends desired to know what stroke and bore the three horse-power motor was, and I informed them it had an 80 mm. stroke and 80 mm. bore, and virtually gave three and a half horse-power, especially after it had worked the piston and cylinder to the ideal looking-glass polish, at which period it should put forth its maximum power of three and a half horse-power at 1,700 to 1,800 revolutions per minute. They pointed out that this motor intimately resembled the standard De Dion air-cooled motor, and my reply was, "The De Dion motor was a genuine success in the hands of its makers, as they knew their motor as well as a mother knows her child, on account of the number of years they had been 'nursing' this special pattern, consequently the higher-powered engine was but a natural development of the tricycle motor."

During this conversation we had again taken our seats, and were making our way through that lovely little town Ville d'Avray, having come along on the top speed, excepting up the hill after leaving St. Cloud, on the left, much to the satisfaction of my friends.

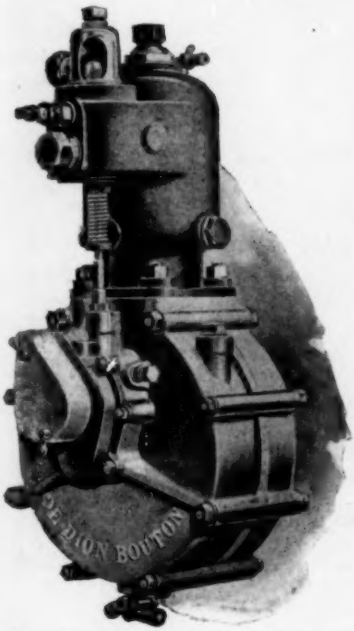
We stopped at the Hotel Cabassud for the usual *apéritif*, it being only about 11.30 A. M., still a glass of sherry did not seem amiss, if only to replace the tasteless rain.

Bent upon knowing every detail of the voiturette thoroughly, they said, "We noticed in changing the speed, by the wheel under the steering bar to the left for slow, and to the right for top speed, it made absolutely no noise."

"No," said I, "this is an ingenious invention due to Monsieur Bouton, and it is probably the most expensive thing to manufacture about the whole carriage."

This, I mentioned, was a difficult piece of mechanism to describe, but I would do my best to satisfy their curiosity. The speed-changing gear is placed alongside the motor, and is closed in an aluminium case. It is composed of two shafts on which are placed four cog wheels of different diameters, meshing

together and being always in gear. The first of these shafts, on which are keyed the pinions, is joined to the motorshaft by means of a coupling sleeve in two pieces. The second shaft is the one on which the throwing in and out of gear takes place. This is effected by the aid of a rack and pinion, which runs through the centre of the second shaft. By moving the rack and pinion rod one way one pair of wheels is put in gear; at the same time the other pair is thrown out. By reversing the action the gear in drive is put out and the other in. The driving is done by two separate friction clutches situated side by side, one being the slow speed and the other the fast speed. Each of these cases contains a set of divided segments of hard composition with metal flanges, and in the centre of each there is a small pinion upon which the rack acts as it moves to the right or left, by which movement the small pinion increases or decreases the diameter of the divided segments. When the rack is moved to the left the small pinion increase the diameter of the segments which bind tightly against the inner surface of the friction case in such a way as to cause the case to drive the toothed wheel connected to it. When the rack is moved along to the right this expands the fast speed segment, and contracts the slow, and when the rack is moved in the centre both clutches are thrown out of gear.



The Three Horse-power Motor with Water Jacket

The hand wheel placed on the pillar underneath the steering bar works the rack of the speed-changing gear by means of a chain.

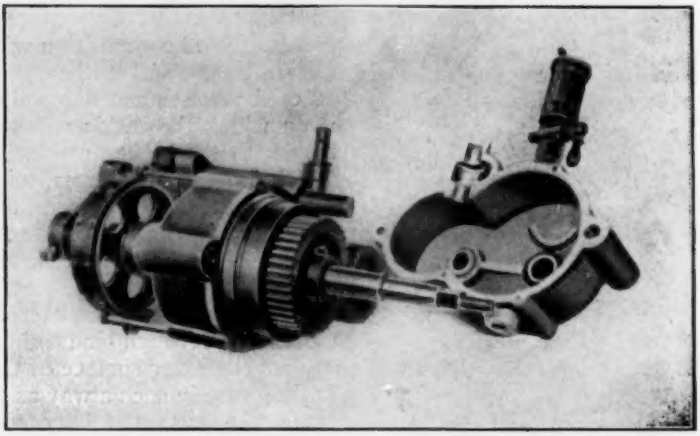
To the extremity of the shaft opposite the rack is fitted the small pinion which gears into the large spur ring encircling the differential gear box.

Twelve o'clock having chimed at the old wayside auberge, I suddenly stopped the conversation and informed my English com-

panions that "in France we usually had *déjeuner* about twelve," and as the keen damp morning had made feelings of hunger apparent, we started the motor on its throbbing way by the handle near the driver's seat, which, as one of my companions remarked, "was in a most convenient position."

I next called my friends' attention to the ascent of the very stiff and celebrated hill of Picardie, well known to cyclists and motorists, up which we simply "romped," and then we coasted down the other side at a forty-miles-an-hour gait.

We drove through Versailles up to the Hotel des Reservoirs, where we ordered *déjeuner,* over which I was able to give them a detailed account of the motor and car, illustrated by the photographs which are here reproduced.



The Two-speed Gear

Whilst lingering over our *café* I gave the following description:

You will have noticed the small De Dion voiturette is distinguished from most small (and large) cars by the simplicity of its machinery, and, at the same time, by its smart and open appearance.

The carriage part is constructed lightly and elegantly with all the sides in sheet aluminium, so that its total weight does not exceed 650 lbs.

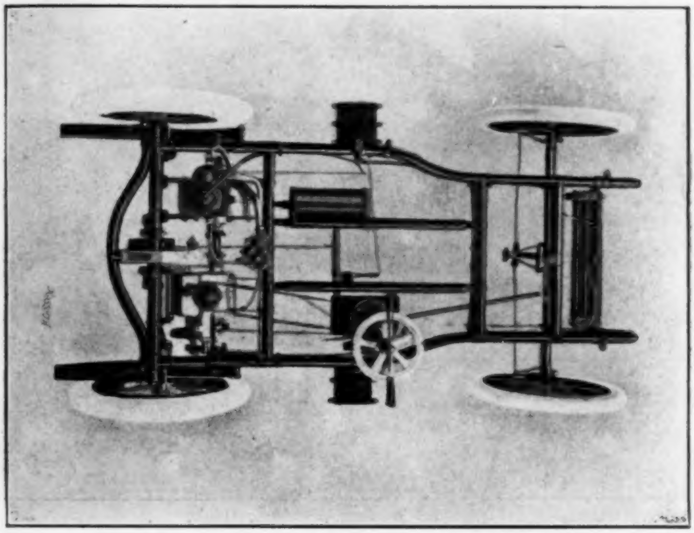
It is made to carry three persons comfortably seated. The four wheels are 26-in. with 2½-in. pneumatic tires on the steerers and 3½-in. on the drivers.

The De Dion Voiturette

The length of the carriage over all is 8 feet, and the width is 4 feet 4 inches. It is fitted with easy springs, and, at the same time, the whole carriage is exceedingly rigid and strong.

There are two brakes, one acting upon the drum on differential gear and one on the speed gear. The speed can be regulated to about twenty miles an hour on level and from six to eight miles up stiff hills.

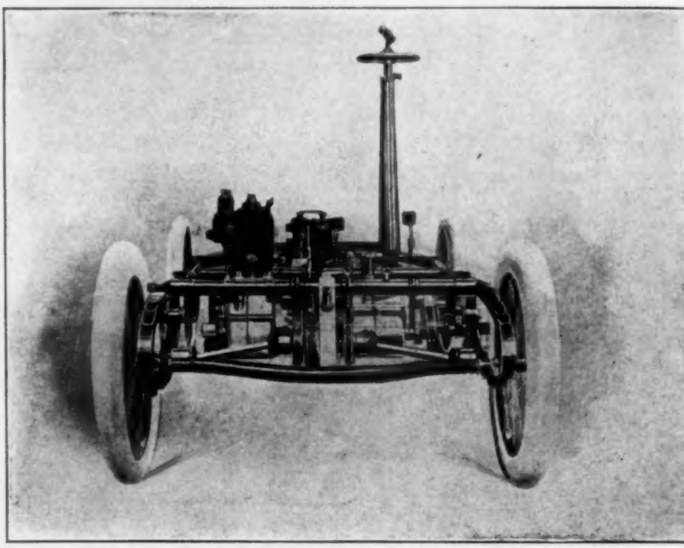
The reservoir contains about two gallons of spirit, and this quantity is sufficient to drive fifty to seventy miles, according to the weather and state of the roads. The capacity of the dry battery is about two hundred working hours.



A Bird's-eye View of the Mechanism with Body Removed

An important feature about the De Dion-Bouton voiturette is that the whole frame, speed and differential gears, axles, driving device *à la cardan,* as we call the universally-jointed axle, motor, and carburetter, have all been designed, manufactured, tested, altered, or improved, where considered necessary, during the past few years solely at their own works, and the fact that it is now being built in batches of hundreds is sufficient to convince the most pessimistic that the De Dion voiturette is likely to prove one of the most successful small cars upon the market at a reasonable price.

It will be seen from the illustration that the back axle is bent to leave the necessary space for the differential gear and to ensure that whilst the spring ends of the axle shall have free and full play, the short central portion, which contains the differential and gears with the countershaft, shall never alter its distance from the latter. At each end of the spindles are fixed the axles *à la cardan,* doing the duty of main driving axle. They are placed at an angle of 3° from the horizontal. The driving wheels are on the two short horizontal continuations of the spindle, and run on ball bearings.



A Back View showing the De Dion Driving Axle à la Cardan

The differential runs on ball bearings, and is mounted in the supports fixed upon the frame. A band brake is fitted to the left side of the differential.

The two axles that it drives have two steel sleeves fitted in each end, in which articulate the extremities of the axles *à la cardan.* The opposite extremities of these axles articulate in the same manner in the sleeves which complete the spindle. The ends of these axles are solid, with square joints, which serve to drive the hubs.

The carburetter is entirely a new departure from the ordinary De Dion carburetter, and is made exclusively by De Dion-Bouton.

and is on the float feed principle, but I cannot give full details just yet.

We now started upon our homeward journey, and one of my friends was anxious to take the driver's seat in order to get accustomed to steering and the general manipulation. After about a quarter of an hour's explanation in regard to the two small levers upon the steering-pillar, one for the mixture and one for the advance, and shutting back the contact breaker, brake pedal, and the electric ignition switch, we started off.

My friend was astonished at the simplicity of driving and ease of steering, but when he changed the speed upon the first stiff hill he burst forth with delight, " Why my wife and daughter will be able to drive this, without the slightest bother, in five minutes."

We sped along on the top speed at a merry pace until we reached Puteaux, where I left my companions thoroughly convinced that the De Dion-Bouton voiturette would be a great success in England. Only one disappointed look came when they asked Count De Dion:

" When can you deliver?"

" Ah, voilà la question."

—*Autocar.*

AUTOMOBILES USED FOR TOWING

The haulage of boats by automobile along the canal between Brussels and Charleroi has demonstrated, after a long trial, that the new method of towing is three times quicker than horse traction. The automobile derives its energy from a railway composed of six lines, three of high tension (6,000 volts) and three of low tension, on which the trolleys run. The electricity is furnished by three dynamos, each of 120 horse-power.

The Canello-Durkopp Motor-Carriage

REFERENCE has already been briefly made in these pages to the motor-vehicles of the Société des Automobiles Canello-Durkopp, of Courbevoie, France, and Bielefeld, Germany. Through the courtesy of the builders we are now able to publish some further information and illustrations of these vehicles which, both in appearance and arrangement, resemble very closely the well-known Panhard-Levassor type of automobiles. Notwithstanding this general resemblance, however, the

Fig. 1. General View of Canello-Durkopp Phaeton

following description indicates that there are many special features in the new cars worthy of close attention. The motor, of 4, 6, or 8 horse-power, as desired, is composed of two vertical cylinders, with incandescent tube ignition. It is placed in the front part of the frame (Fig. 2), and is concealed from view by a sheet-iron bonnet, as in the Panhard cars. Water for cooling is circulated by a thermo-syphon when the power is low and by a pump driven by a friction on the fly-wheel or by a gear on the regulating shaft in the large-sized motors. The inlet valves are automatic, as usual, and the exhaust valves are raised by a cam shaft located in a case and controlled by reduction gears *J*. The sectional view of the motor (Fig. 3) shows that the connecting rods are balanced by a counterweight, *Z*, attached to the motor-

shaft I, which on the left end has the starting gear 4, and on the right the fly-wheel F, hollowed out to receive the male portion of the friction clutch, by which means the motor is disconnected from the transmission gear.

The method of controlling the valves by cams and the governor is represented in Fig. 4. M is the motor-pinion engaging with the wheel L, attached to the cam shaft A. This shaft slides in the bearing $E\ E'$, which are fastened to the shaft by means of the keys R, allowing it to slide in these bearings, but forcing it when it turns to carry with it the bearings P, movable in the bearings O, the latter being fixed to special supports. The pinion M is of sufficient width that whatever the displacement of the shaft A it is always in gear with the wheel L. It will be seen that the shaft A carries the cams B and B', provided with pro-

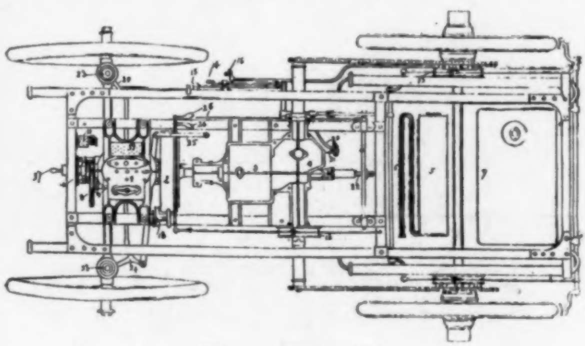


Fig. 2. Plan of Car

jections b and b', of eccentric form, which act upon the rollers C and C', attached to the ends of rods D and D', which control the exhaust valves. The position represented in Fig. 4 corresponds to the moment when the roller C, being in full contact with the projection b, the corresponding valve is wide open, the valve controlled by the rod D' being closed. A centrifugal ball governor turns with the shaft A. If the motor "races" the centrifugal force, overcoming the power of the springs I', will throw out the balls I. A force will then be exerted upon the collar K tending to move the shaft A sufficiently backward to bring the projections $b\ b'$ out of contact with the rollers $C\ C'$. Consequently the rods D and D' are no longer raised at each revolution of the shaft A, and as the corresponding valves remain closed, the motor will slow down until the spring I', acting upon the governor and upon the shaft A, brings the latter to its former position—*i. e.*, brings

the eccentric projections b b' back into play with the pulleys C C'. In order to exceed the fixed maximum speed in certain cases the operator is able by means of the rod H controlling the bell crank G G, which acts upon a fork in the grooved collar F F', to force the shaft A into the normal position.

As has been already stated, the motor is located in front. It is so placed that the motor shaft and the fly-wheel are in the longitudinal axis of the vehicle. The burners are located at 19;

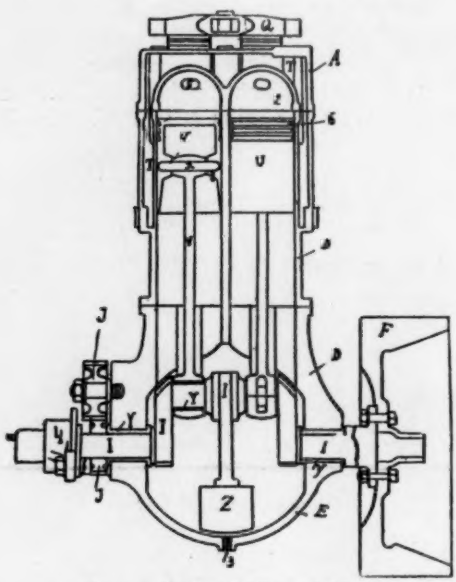


Fig. 3. Sectional View of Motor

at 10 and 11 starting gear; at 8 and 9 the regulation gear; at 11 the carbureter. The motor drives a longitudinal shaft through the medium of a friction clutch 2, controlled by the lever 22. The case containing the speed-changing gears is located at 3, while 4 is the case enclosing the differential upon the counter-shaft which command the rear road wheels by pinions and chains. At 7 is the water tank, holding thirty litres; the petrol tank, having a capacity of twenty-two litres, is in front. 18 is the centrifugal pump for the circulation of the water, while 5 is the muffler, the radiating coil being located below at 6. Four speeds forward and reverse motion are provided. Particulars of the

variable speed gear and of the special steering connections employed in these vehicles will be given in a subsequent issue.

The Canello-Durkopp Company is making a number of different types of cars, Fig. 1 showing a 6 horse-power four-seated phaeton. Four brakes are provided: a band brake (12) on the differential shaft, controlled by a foot-pedal (26); two band brakes (13) on the rear axle, actuated by the handle (15), and tire brakes (17) applied by the screw 16.

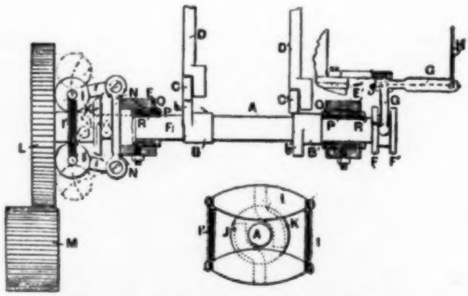


Fig. 4. Exhaust-valve Control Gear

Two New English Motor-Voiturettes

IT has already been stated in these columns that, just as in France, there is a distinct movement in this country in favor of the voiturette class of automobile, and this week we are able to give illustrations of two new cars of this type of English construction.

Fig. 1 gives a general view of the Billings voiturette, which is being introduced by Mr. J. Burns, of Berners street, London,

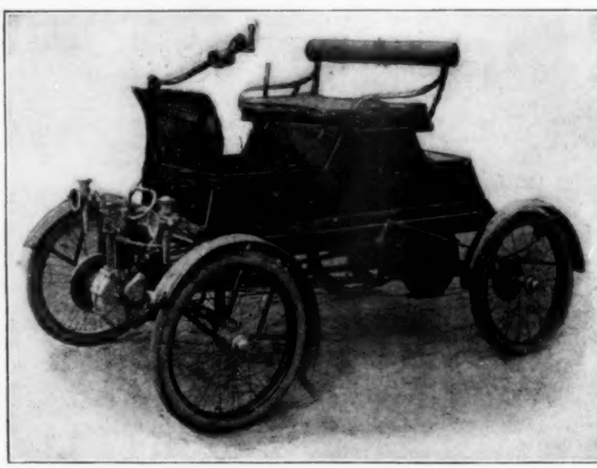


Fig. 1. The Billings Voiturette

W., and on one of which we had the pleasure of a short run on Tuesday in company with Mr. Billings, the designer of the car. As will be seen, the vehicle is propelled by means of a 2¼ horse-power air-cooled De Dion motor, located in the front part of the frame. The latter is of special tubular construction, there being practically two frames suitably braced together, suspended by steel springs on the axles. Two speeds are provided—six and twelve miles per hour, on the car we tried—the power being transmitted by belts working on fast and loose pulleys to a small differential counter-shaft at the rear, and from the latter to the

back axle by enclosed pinions centrally located. Not only is the car so arranged that the motor can, if desired, be started from the seat, but the oil from the crank case can be emptied and a fresh supply injected without the driver dismounting. Steering is effected by a tiller, the standard of which is located in front of the dash-board; the road wheels are of the cycle type, with pneumatic tires, while as to brakes there is one on the counter-shaft and one each on the hubs of the rear wheels. The petrol tank has a capacity sufficient for a run of 100 miles. The car, which only weighs 400 pounds, has already been driven several hundred miles, and is stated to have mounted a gradient of 1 in 10 with two passengers aboard. As a result of his tests with the

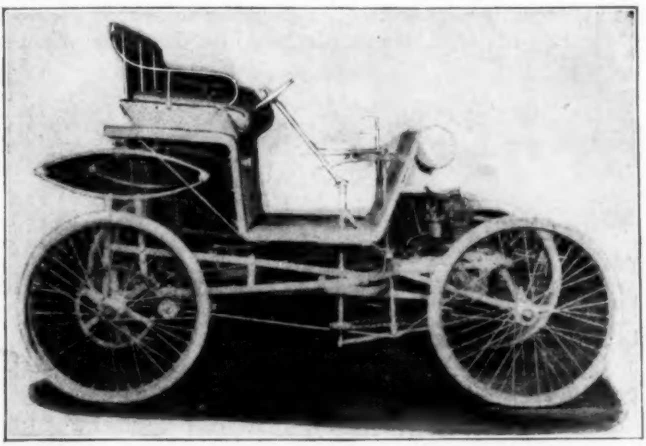


Fig. 2. The Monk and Lonsdale Voiturette

car, however, Mr. Billings informs us that he has resolved to fit future cars with a 3 horse-power water-cooled De Dion motor, in order to have a greater reserve of power at command than is possible with the air-cooled engine. Although the illustration shows the motor not to be provided with a bonnet, this will, of course, be fitted to all cars turned out, a number being, we understand, already in process of construction.

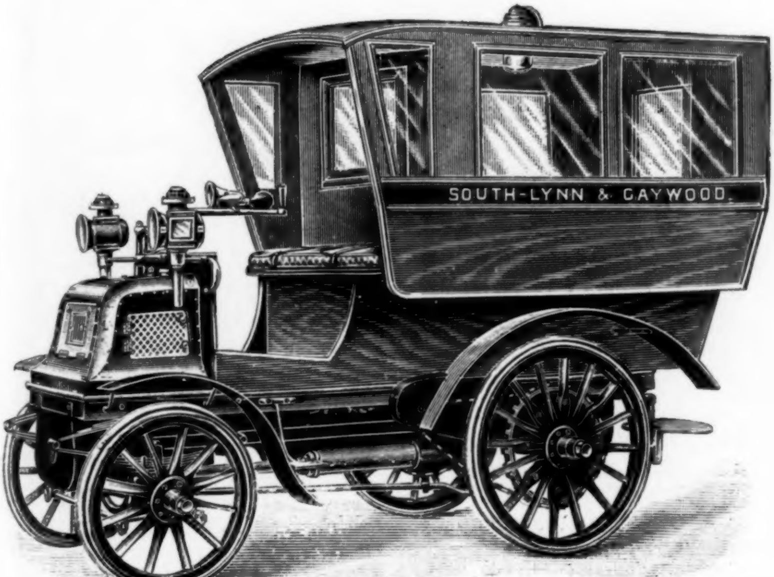
In Fig. 2 we give an illustration of the two-seated motor-voiturette lately constructed by Messrs. Monk and Lonsdale, of the Marlborough Motor Works, North Road, Brighton. The car is propelled by a 2½ horse-power vertical air-cooled motor, placed in the front of the frame; it is belt-driven, two speeds of

five and twelve miles an hour and a reverse motion being provided. The speeds are changed by a single lever. The frame throughout is made of spring steel riveted together. Steering is controlled by a sloping hand-wheel, in the standard of which a universal joint is introduced, so that it can be moved to allow for getting in and out of the car. Oil-retaining bearings, and a new type of silencer, are fitted, while provision is made for the engine to be started from the seat or in the ordinary way. Messrs. Monk and Lonsdale in sending us the particulars state that the photo., although not showing the car in its perfectly finished state, is quite enough to indicate the general arrangement. The body will, of course, be better finished than in the illustration, and C springs will be fitted, while the front will have a detachable cover to go over the engine. They further state that everything, except the raw material, is manufactured on their own premises.

The Morriss Motor-Omnibus

ONE of the most enterprising firms in the Eastern counties is undoubtedly that of Mr. Frank Morriss of the Motor and Cycle Works, London Road, King's Lynn. As mentioned in a recent issue of this journal, the latest venture of this gentleman is the establishment of a regular motor-omnibus service in the town—from South Gates to Gaywood. We are this week able to give an illustration of the vehicle which has been built by Mr. Morriss in his own works for this service, from which it will be seen that the 'bus has quite an attractive appearance. One noticeable feature of it is the protection afforded to the driver, the roof having been continued beyond the body of the vehicle to cover the "box," the sides of which are also enclosed. The propelling power is a 5½ horse-power Daimler motor mounted on a Daimler standard frame. The car is geared to a maximum of twelve miles per hour, and the body is mounted on hanging springs, and rides very easily. The vehicle is licensed to carry ten passengers—eight inside and two on the box; and their comfort has been well studied, the inside being nicely upholstered; there is also the novelty of a roof oil-lamp (of the type

of those found in railway carriages) and a lever clock, while an electric bell affords communication between the conductor and the driver. The 'bus is timed to leave the South Gates every hour, commencing at 9 A. M., allowing twenty-seven minutes to arrive at Gaywood. There is a three-minute stoppage, and each hour, commencing at 9.30 A. M., the 'bus will travel from Gaywood to the South Gates. The fares are a penny from one stopping-place to the other, or twopence from the South Gates to Gaywood, or *vice versa*. Mr. Morriss informs us that he can supply these 'buses either complete with motor and frame or the bodies separately for fitting to customers' own frames.



The Morriss Motor-Omnibus

The Shaw Motor Bicycle

A STRONG looking motor bicycle with a good long wheelbase has been made by Messrs. Ambrose Shaw and Son, of the Gazelle Works, Crawley. The machine is driven by a 1¾ horse-power De Dion motor. Electric ignition is, of course, fitted, so that the speed can be varied in the same way as on a tricycle. A noiseless gear can be fitted to connect the motorshaft with the countershaft, instead of the chain driving throughout, as shown in our illustration. The appearance of the machine will be improved in future by the carbureter and battery being contained in one case. It will be seen that no provision

for pedal driving or pedal assistance is made on this machine, the pedals merely being used as footrests. Starting is effected by opening the compression tap and pushing the machine off. As soon as the motor commences to run, the rider steps into the saddle and closes the compression tap. The firm are working out a tricycle which, we understand, will practically be on the same lines as the bicycle, that is to say, with the motor in the same position as shown, and with a chain drive throughout, so that there will be no noise from any toothed gearing. The only difference between the bicycle and the tricycle will be in the fact that two back wheels, an axle, and a balance gear will be fitted to the latter with proper splayed stays from the saddle to axle sleeves.

The Hugot Motor-Voiturette

AMONG the many new types of light motor-voiturettes lately introduced is the one illustrated herewith, and made by M. Hugot, of 8 Rue Sainte Apoline, Paris. The body of the car is suspended on the steel frame by C springs at the rear and plate springs at the front, which are claimed to reduce the vibration experienced by the riders to a minimum. The vehicle has accommodation for three persons, two facing the direction of progression and one on a seat contrived at the

Fig. 1. General View

front on the box containing the battery, tools, etc. M. Hugot employs a 2¼ horse-power De Dion motor of the latest type, the ignition being, of course, electrical and the cooling by means of radial discs around the cylinders. The carbureter is of the Longuemare type. Two speeds are provided, by means of which, assisted by the variation of the sparking device, speeds of from 14 to 28 kilometres per hour on level roads and from 4 to 14 kilometres uphill can, it is claimed, be obtained. The transmission and variable speed gear presents some interesting features. As will be seen from Fig. 2, the motor is located at the back of the car and drives the rear road wheels, represented by *M* and *K*,

through the intermediary of the pinion *B* and the differential gear, which is made up of the pinions *C, D, E, F*. At *J* is an ordinary step clutch, by means of which the wheel *K* can be made rigidly connected with the right half of the axle or to run loose on the same. When the low speed is in gear, which in the Hugot car is the normal position of the transmission device, the wheel *K* is rigidly connected with its part of the axle, and the transmission of the power of the motor is made to the two rear road wheels through the differential gear. Around the differential gear is a gear case which also serves as a drum for the low-speed brake (not shown in Fig. 2). To change over from the low to the high speed the band brake *G* is tightened, the clutch *J* being at the same time thrown out, so causing the wheel *K* to run

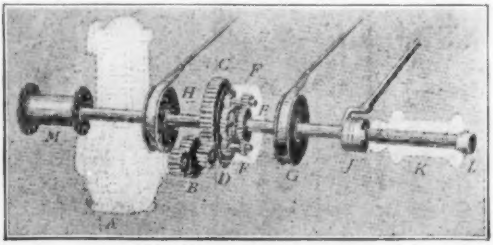


Fig. 2. View of Hugot Variable Speed Gear

loose on its axle, the result being that the wheel *M* becomes the only driven one and runs at double the speed of the low gear. To change back again the high-speed band brake *H* is applied. The gear is both simple and ingenious, the only drawback we can notice being that at the high speed only one of the rear wheels is driven. As the high speed in voiturettes is never very excessive it is probable that the drawback alluded to is more imaginary than real. The car weighs rather less than 4 cwt., and can, it is claimed, mount gradients of 1 in 10. The road wheels are of the suspension type, fitted with pneumatic tires; the car is 8 feet long by 3½ feet wide. The Hugot car is being introduced into this country under the name of the "Paris" by the United Motor Industries, of 3 Rue Meyerbeer, Paris.

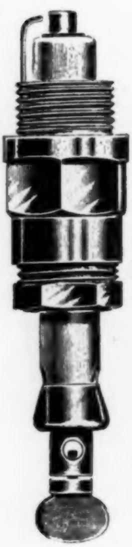
A New French Steam Omnibus

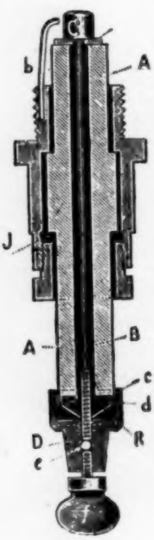
LA Compagnie Nationale des Courriers Automobiles, of 22 Rue Rossini, Paris, have lately constructed a new steam omnibus, of which a general view is given herewith. The car is propelled by a 14 horse-power two-cylinder compound engine, steam for which is supplied by a Thirion tubular inexplosible boiler. The engines are so located under the floor of the car that each cylinder drives one of the rear road wheels through chain gearing. The vehicle has accommodation for fifteen per-

sons, including the driver, and can, in addition, carry 12 cwt. of luggage or merchandise. The water tank has a capacity of 300 litres, which, states *L'Avenir de Automobile,* to whom we are indebted for the illustration, is sufficient for a run of thirty kilometres. Steering is controlled by a vertical hand wheel, while the driver has three breaks at his command. The wheels, which are of wood with iron tires, are 31½ inches in diameter in front, and 47 inches at the rear. The weight of the 'bus complete is given as 2 tons 15 cwt.

The Georges Richard Sparking Plug

THE ordinary sparking plug consists of a metal spindle passing down the centre of a porcelain tube, its end being near another rod which is connected to the main body of the motor. Between these two rods the spark passes. The rod passing down the axis of the plug is fixed either by some kind of cement or by two screws, which hold it between their ends.





These two systems have their disadvantages. Under the influence of the high temperature cements deteriorate, while, on the other hand, if the rod is fixed by means of screws it comes about that, owing to the difference in the expansions of the rod and the porcelain, the joints are altered in such a way that a current of gas or air sufficient to extinguish the spark may be produced around the rod.

The figure indicates the method by which Mr. Georges Richard seeks to avoid these causes of breakdown. A is the porcelain tube inclosing a metal rod, B, at the end of which is a head, C, separated from the end of the porcelain tube by a copper washer, *a*. Close to the head, C, is the rod, *b*, which is connected to the mass of the motor. At the other end of the tube is an asbestos washer, *c*, over which is another copper washer, *d*. A spring, R, presses against this washer.

According to the usual practice the rod, B, has its end threaded to receive the nut, D, by means of which the rod, B, is firmly held

in the porcelain tube; this nut, D, receiving the conductor, *e*, of the electric current; *e* being held by the thumb-screw, *f*.

Owing to the spring, R, which is compressed by the screw, D, the head, C, is pressed firmly against the tube, A, and there is also a tight joint at the other end between *c, d* and A. Thus a good joint is formed which does not allow the passage of gas or air when the parts expand, the difference in expansion being met by the action of the spring.

AN AUTOMOBILE SLEIGH

The curious automobile sleigh shown in the accompanying illustration consists of a Bollee gasoline automobile altered by the removal of its front wheels and their replacement by runners to adapt it to be used on ice and snow. A wooden rim carrying conical points is put around the rear motor wheel and gives a sufficient bearing on the surface of the ice to propel the vehicle. This curious automobile was designed and made by Dr. E. Cas-

En Tour

grain, of Quebec. The reservoir of gasoline holds enough for a run of 45 miles and the motor develops two horse-power. The vehicle can be speeded at will from 5 to 14 miles per hour. The whole running gear and frame of the machine is made of hollow tubing, the front runners doing the steering. We are indebted to the *Literary Digest* for the illustration of this interesting automobile.

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Editorial Comment

THE MOTOCYCLE

THE organization of the Motocycle Club in Boston is significant, as indicating a growing popularity of that form of the automobile in this country. It is, we believe, the first organization in the United States specially devoted to that style of vehicle. In France the motocycle is exceedingly popular; in fact, the most popular of all motor-vehicles, but in this country various reasons have given the automobile proper the precedence. The motocycle is a combination of the cycle and the automobile idea. It has the pedals and the saddle of the former and the motor of the latter, and in general shape is an evolution from the bicycle rather than from the animal-traction vehicle. In its combination of muscular and mechanical traction it may be compared to the sailing vessel with auxiliary steam-power—once a familiar form of ocean craft, but now nearly obsolete. In the motocycle, however, it is the muscular traction that furnishes the auxiliary power, pedalling being resorted to for starting the motor, while the machine may also be pedalled home in case of a breakdown in the mechanism—a pretty laborious process, to be sure, comparable to rowing a motor-launch to the shore when the machinery refuses to work—as is too often the case with the

freaky explosion-engine type. Since the motocycle is of comparatively low cost, we may look to see it achieve a rapid advance in popularity. But we hope it will not become the scorching nuisance upon our highways that it is in France. The motor-bicycle is growing in favor, but is a dangerous machine, not to be commended for general use. The tricycle and the quadricycle are the best forms, and we may expect to see notable improvements in their manufacture in this country.

Railways and the Automobile

It is not unlikely that the automobile, although to a certain extent a rival of the railway, may prove eventually a very powerful auxiliary. And this service it may perform for both steam and street railway. There are certain indications of the direction which such a development may take. For example, the New York Central and the Pennsylvania Railway Companies have established excellent cab-services in connection with their terminal stations, the former in New York and the latter in both New York and Philadelphia. The former, it is said, proposes to establish a similar service in the principal cities along its line, as in Albany, Syracuse, Rochester, Buffalo, etc. And in all likelihood, on taking over the Boston and Albany, it will establish such a system in Boston, possibly in conjunction with its co-occupant of the great South station in that city—the New York, New Haven and Hartford Railroad Company. It is said that, as soon as practicable, both the Central and the Pennsylvania will substitute mechanical traction for animal traction in these cab services. Again, the Boston and Maine Railroad owns and operates the electric street-railway service in Portsmouth, New Hampshire, with excellent results, and the New York, New Haven and Hartford controls or operates extensive lines of electric cars near New York, Boston and Hartford. Now why might not a great steam railway go a step farther and run automobile omnibus lines at every important station along its line, transporting passengers at low rates to and from their homes? The automobile might thus become a powerful feeder for the railway. Again, there would seem to be a field for the automobile as a feeder for street-railway systems as well, with motor-omnibus lines running to points where it would be impracticable to construct the railway itself.

The Tire Problem

The tire appears to be the element that is giving the most concern to automobile manufacturers just now, or at least the makers of heavy vehicles devoted to passenger transportation. The pneumatic tire for bicycles had been carried to such a degree of perfection, and it had been applied so successfully to horse-drawn vehicles, that it had been taken for granted that practically no difficulty would attend its adaptation to automobile requirements. Its extraordinarily strong construction for the new purposes, with special provisions against puncturing, were deemed to be ample for making it conform to automobile work. But the tremendous wear and tear to which the tire is subjected in its work of sustaining a load so heavy as the electric vehicle, with its dead weight in storage-battery, was all too lightly reckoned with. Under such a strain the life of a set of tires is exceedingly short, and since they are pretty costly items, their frequent renewal makes an enormous figure in the annual maintenance charge—a figure that has quite upset all calculations as to profit on the part of the transportation companies to whom automobile traction seemed such an assured bonanza.

There is nothing, however, disheartening in this development, unpleasant as it is. It is merely one of the drawbacks that inevitably attends every notable advance in inventive science. The difficulty is slight in comparison with the obstacles that the steam railway had to overcome, or the steamboat, or even the development of electric traction. It simply for awhile makes sailing less smooth than had been anticipated. Human ingenuity can be depended upon to overcome the obstacle in the comparatively near future. For all we know to the contrary, it may, indeed, already have been surmounted.

The bicycle did not teach us everything there was to be known about the rubber tire, after all. It looks as if, in relation to the automobile, a course of experimentive development in regard to the tire would have to be gone through with, comparable to that which characterized the evolution of the bicycle. And possibly the perfected shape will be something as radically different from anything now existing as the pneumatic tire differs from the narrow rim of rubber that, in the old high wheel, proved the foundation of the bicycle's potency.

At present the tendency appears to be away from the pneumatic tire. In its huge and disproportionate bulk it has been the chief contributor to the clumsy aspect of the electric cab as until recently known, and has been the main element in giving that vehicle the look of a steam roller. Surely nothing so ungainly

to the eye ought to be mechanically efficient! The new cabs, however, that have made their appearance this season are of a model that in elegance vie with the hansom, or any other horse-drawn vehicle. The effect of lightness is enhanced by the substitution of the cushion tire for the pneumatic, with well-designed wooden wheels, a superior construction of springs doubtless making up for any inferiority to the pneumatic which this form of tire may have. And should its life prove less than that of the pneumatic, the difference in original cost ought to bring the maintenance charge within reasonable limits.

The Odor Problem

With the multiplicity of automobiles the problem of offensive odor will have to be solved. While those that use petroleum in any shape remain comparatively few in number, there will be little trouble. The occupants of the vehicle do not mind it, for they leave their scent behind them. But if they chance to run behind another vehicle like their own, they are apt to curse the other fellow roundly, just as people in their rear curse them! With a road filled with such automobiles the effect would be extremely unpleasant to all concerned. A little unconsumed petroleum vapor will charge many thousand cubic yards of air with its odor, and when the atmosphere is humid and calm the smell will linger long in one place. A public park, with pleasure-drives thus thronged, would be intolerable. It is important to know, however, that perfect combustion prevents odor and that in the average gasoline motor now employed in automobile practice the combustion is remarkably complete. Where does the smell come from, then? An eminent authority finds that it proceeds, not from the products of combustion, but from the lubricants, which, becoming vaporized by the heat of the motor, leave their scent in the air. It may, perhaps, be an expensive and difficult task to avoid this. If, however, in some way, inoffensive and deodorized lubricants can be used, or if the vapors which they produce can be superheated so as to consume their gases, the offending cause will be abolished. Perhaps the remedy will ultimately turn out to be relatively simple. The problem will have to be solved sooner or later.

The Letter That Killeth

An amusing, though annoying, instance of corporate chuckleheadedness is reported by an English automobilist in Worcestershire, England. He had often crossed a certain toll-bridge, paying the costly rate of nine pence a time, but it saved him a

detour of 12 miles. The last time, however, he was absolutely refused passage across. Complaining to the corporation owning the bridge, he was answered that the bridge had been purchased by the county council and would be shortly made free to the public. Meanwhile an old act of Parliament controlling the bridge, which did not provide for its use by automobiles, would have to be observed, and the gatekeeper had been instructed not to allow any to pass!

Improvements in Construction

A recent number of the *Autocar* comments on the marvelous progress in improvements in automobile construction made in the past three years: "In the first place we have but to point to the speeds made in the great continental races. It is but three years ago that an average speed of fifteen miles per hour throughout one of these long contests produced a winning car, whereas, to quote the latest instance, the Gordon Bennett cup race, the average was very little short of forty miles per hour. And this increased speed has not been obtained entirely by the increase of motor power, but by general attention to details throughout the vehicle, to the lessening of friction in the transmission gear, to the reduction of weight in the car and its mechanism, and to the use of pneumatic tires. To come nearer home, we may recall the fact that on our John-o'-Groat's tour—which was carried out less than three years since—we averaged over no single stretch of the journey more than twelve miles per hour, and in comparison with this we may quote the performance of a member of the Automobile Club, who finished up the Whitsuntide tour by a run from Cambridge via Bedford, Aylesbury, Oxford and Maidenhead to London, a distance of 149¾ miles, in 9 hours 49 minutes running time, which gives an average of 18.9 miles per hour, or, including all stoppages for meals, etc., of 15.2 miles, this latter average including also the slowing down when passing through the numerous towns encountered *en route,* the many stops for cattle, etc., and one stop to relight a lamp. This comparison is interesting because the car was fitted with an identical motor, both as to the make and power, to our own, and carried three passengers, the third person about counterbalancing the baggage and supplies with which our car was loaded. The difference in the two cars is mainly to be found in the reduction of weight—some seven hundred-weight—pneumatic *vs.* solid tires, a higher gearing, and the use of an accelerator, but the difference in the two performances is a striking commentary on the assertion that no improvements have been made."